May 1943

TECHNOLOGY REVIEW

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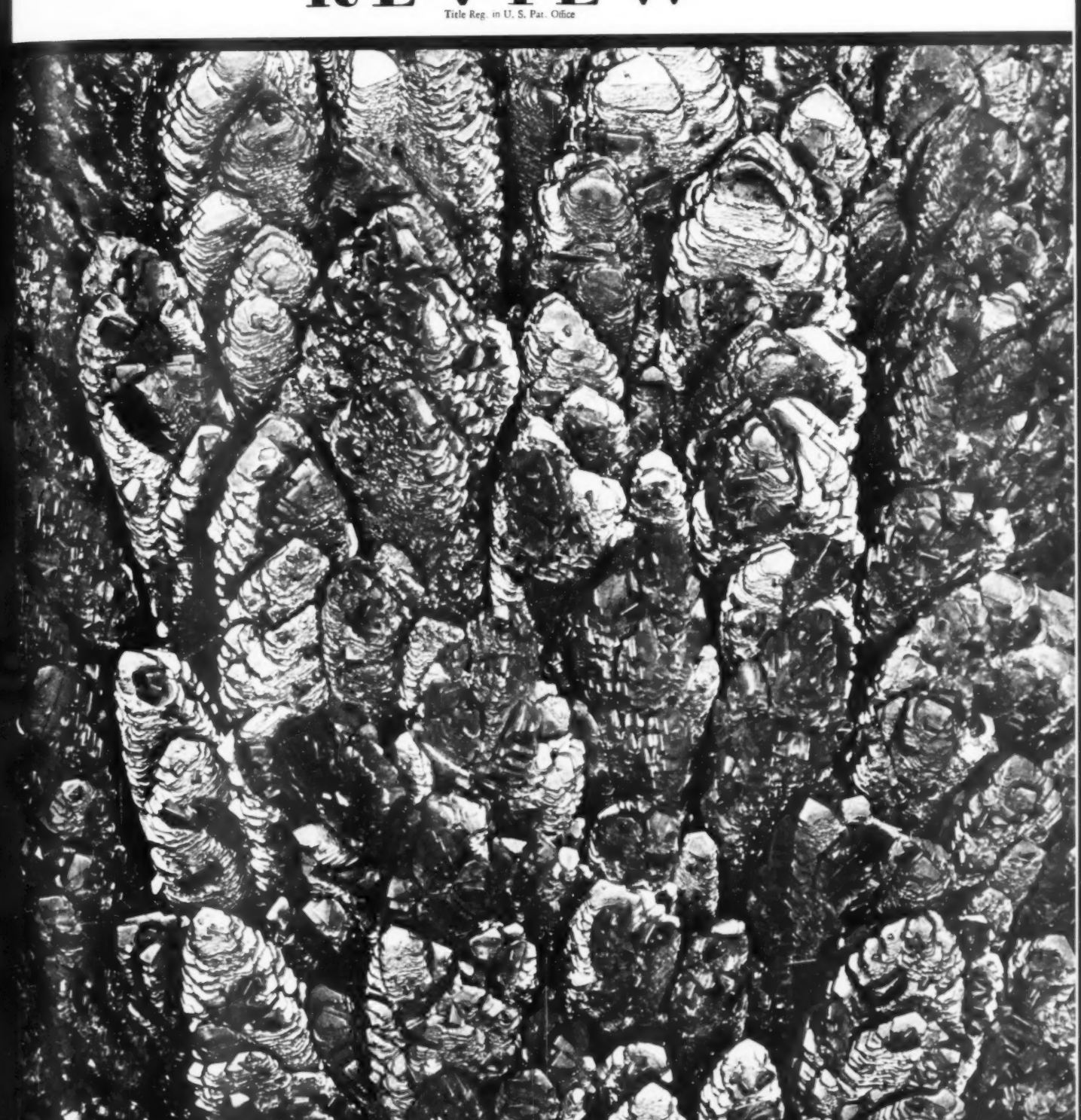

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With each development the Grindlins go into action.

The Norton idea of providing special structures of Grinding Wheels for specific types of work cannot be "whispered" down.

Yes, the Norton No. 12—extreme open structure may double or even treble your grinding machine production—IF THE JOB CALLS FOR THIS KIND OF WHEEL.

But a No. 8- or 5- or 3-structure wheel may look more like the "wonder wheel" IF you have been using the WRONG grain, grade or structure combination on the job.

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SOUTHBRIDGE, MASSACHUSETTS

THE TECHNOLOGY REVIEW, May, 1943. Vol. XLV, No. 7. Published monthly from November to July inclusive at 10 Ferry Street, Concord, N. H. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00. Entered as second-class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879.

Unlike an angleworm TYGON IS STILL FLEXIBLE AT 80° BELOW!

RUBBER and angleworms have this in common: at room temperatures both possess flexibility — at 80° below neither can wiggle a molecule!

Unlike an angleworm, unlike rubber, certain Tygon formulations retain their flexibility at temperatures even lower than 80° below. In fact, one Tygon formulation can be readily bent in an 180° arc at 105° below zero!

This startling characteristic of Tygon is but one of many amazing properties of this versatile rubber-like synthetic.

Tygon was originally developed as a corrosion-resistant material for the process industries, and has been used for several years as a protective lining for tanks and equipment in which corrosives are made and handled. Tygon's ability to withstand the oxidizing elements that attack rubber, its resistance to most of the corrosive agents which attack metals, plus its remarkable flexibility in application, has extended its usefulness to all industry seeking a material with the physical properties of rubber but without rubber's characteristic weaknesses.

Tygon molded and extruded items, for example, possess remarkable resistance to corrosion, show no tendency to swell in the presence of oil or water, have an abrasion resistance in excess of rubber, and a dielectric strength in many cases over 1000 volts per mil. Tygon molding formulations are non-corrosive to metal, and may be molded to extremely close tolerances. Tygon flexible tubing, in tests on high speed vibrating automatic machines, has consistently shown a flex life ten to twelve times that of rubber. Tygon is non-toxic which permits its use on food and beverage equipment.

In addition to molding and extruding formulations, Tygon is made in rigid or flexible sheets for use as protective linings or for gasketing; and in liquid form for use as a corrosion-resistant paint, or for impregnation of fabrics.

If your design problems call for the use of rubber-like materials where such factors as strength, durability, low temperature flexibility, resistance to corrosion and abrasion, are important — it will pay you to investigate Tygon. Write today, without obligation, for Bulletin 1621-A. Address your requests to: Engineering Department, U. S. Stoneware Company, Akron, Ohio. In Canada, to: Chamberlain Engineering, Ltd., Montreal.

U. S. STONEWARE

AKRON, OHIO

ENGINEERS • MANUFACTURERS • ERECTORS *of* CORROSION-RESISTANT EQUIPMENT

Wartime readjustments . . . #8

AMERICANS are willingly adjusting themselves to wartime rationing, but every one will be happier when the need is over.

The burden is heaviest on Mother. She's getting a taste of the severe budgeting that could become permanent, if she were left with inadequate life insurance.

No man wants to ration his family for life—for lack of life insurance. With taxes and War Bonds, money for life insurance may be hard to save — but the effort is *doubly* worth while in wartime!

For life insurance premium dollars are *fighting* dollars. Through investment in basic war industries—and in Government Bonds—premium dollars support the war program, combat inflation, and provide protection for American families.

Talk things over today with a New England Mutual representative . . . so *your* family won't be rationed in the post-war world!

New England Mutual contracts meet present-day needs because:

1. **DIVIDENDS** begin at the end of the *first* year.
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3. **A PREMIUM LOAN** is available beginning with the *second* annual premium.

New England Mutual

Life Insurance Company of Boston

George Willard Smith, President Agencies in Principal Cities Coast to Coast

The First Mutual Life Insurance Company Chartered in America—1835

Call another kind of conference!

A little study makes ration coupons go farther — and makes insurance dollars go farther, too.

But you don't need an adding machine, an abacus, and a family huddle to readjust your wartime insurance program. One able underwriter is enough.

A number of them are listed below. They're alumni of your college and they talk your language. They are also trained representatives of the First Mutual Life Insurance Company Chartered in America.

Out of their experience you'll get *practical*, constructive suggestions. They'll help you make the most of your limited life insurance dollars — help you protect your present policies with premium loans if necessary. Call an *insurance* conference and check your protection *now when you need it most.*

RAYMOND P. MILLER, '18
Salem

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ARTHUR C. KENISON, '19
Boston

▪

BLAYLOCK ATHERTON, '24
Nashua

If none of these folks is near you, you can get similar service at the New England Mutual office in your city. Or use the coupon below, and the Home Office will be glad to have a competent representative confer with you. There is no obligation, of course.

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Box 1-3, 501 Boylston St., Boston, Mass.

Please have one of your representatives get in touch with me, without obligation on my part.

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*Street*_____

*City*_____

*State*_____

Bus to Berlin

EVERY TIME I take the bus in the morning I think, "I'm going home!"

Going home—*by way of Berlin.*

Not for the fun of it, but because that is the way we all must go.

Tom's on *his* way, too—he's going by way of Iceland, and Ireland, and Casablanca.

And I'm on *my* way, too—by way of Elm Avenue, and Main Street, and the Boulevard, to Gate 10 every morning.

For my job in a war plant, and Tom's job in the war itself, are just different parts of the same journey.

It's the *long way* to go, but it's the *only way*.

For home, you know, isn't just a place and a roof.

It's love, and security, and freedom from fear and want and drudgery, and freedom itself!

So I don't count the miles any more, I just count the stops—on the way to Berlin and Tokio.

Because the roads to Berlin all lead home again!

* * *

NOT ALL of our progress on the road that leads to Berlin and Tokio, and back home again, can be measured in terms of miles or military objectives—though these are the payoff.

The performance of a single worker in a war industry, or the discovery of a single scientist, is real progress.

Or the production of a single company. General Electric produced a billion dollars' worth of war products in 1942!

Or new problems solved—research in electronics, metallurgy, plastics, television, or incandescent and fluorescent lighting.

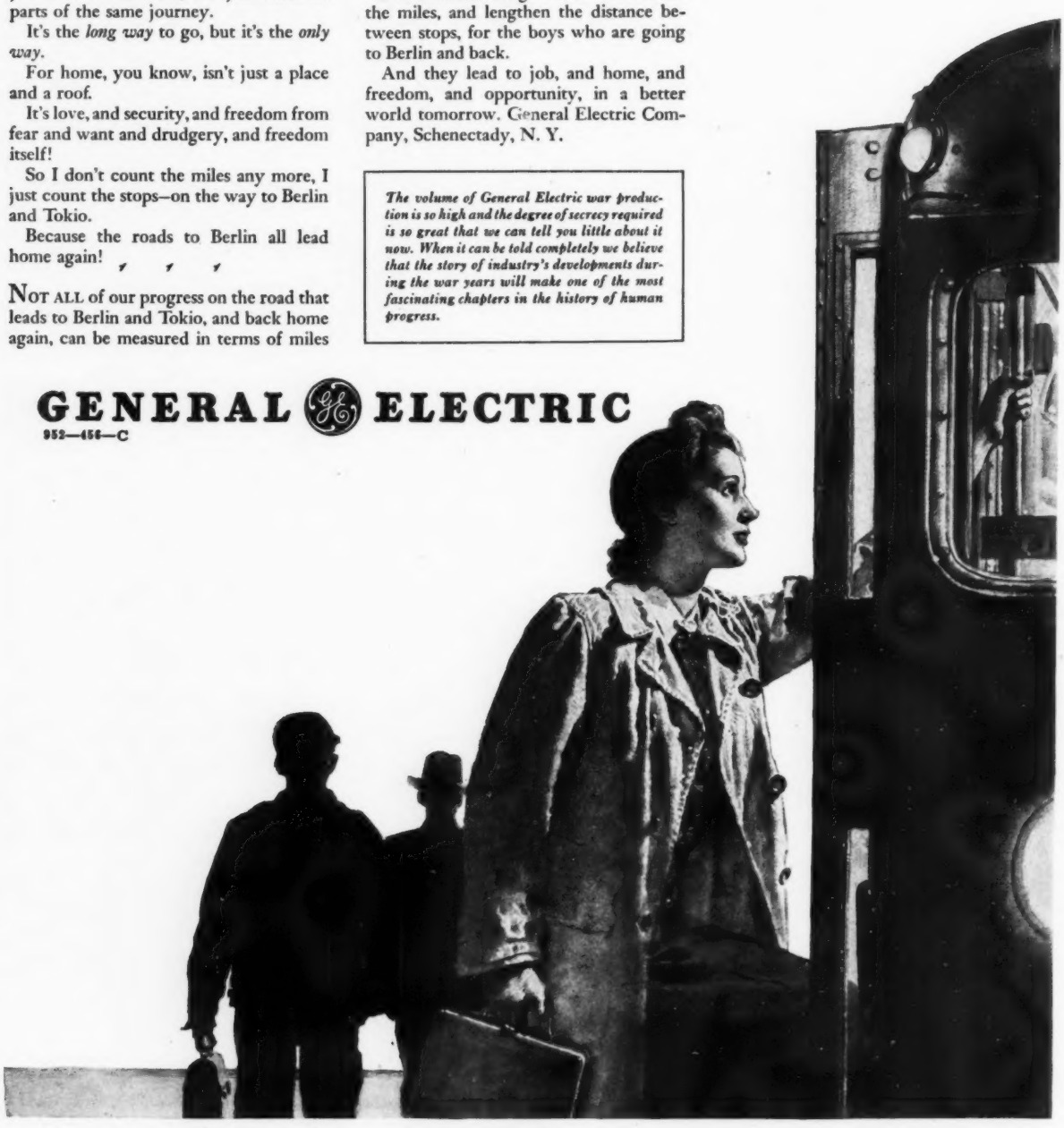
For these are things which will shorten the miles, and lengthen the distance between stops, for the boys who are going to Berlin and back.

And they lead to job, and home, and freedom, and opportunity, in a better world tomorrow. General Electric Company, Schenectady, N. Y.

The volume of General Electric war production is so high and the degree of secrecy required is so great that we can tell you little about it now. When it can be told completely we believe that the story of industry's developments during the war years will make one of the most fascinating chapters in the history of human progress.

GENERAL ELECTRIC

952—456—C



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THE ONLY REAL HERMETICALLY-SEALED RESISTORS

...that will stand the most severe salt water immersion and temperature shock tests

SPRAGUE

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POWER WIRE WOUND RESISTORS AND METER MULTIPLIERS

These Koolohms, designed for the toughest resistor applications facing the industry today, again emphasize the importance of exclusive Koolohm construction features combined with Koolohm engineering ingenuity in solving almost any wire wound resistor problem.

For Koolohms are entirely different from conventional wire wounds. There are no other resistors like them. No other type of resistor can match their performance on exacting jobs. AVAILABLE WITH NON-INDUCTIVE WINDINGS. Get the facts! Write for catalog and sample Koolohms. SPRAGUE SPECIALTIES COMPANY (Resistor Division), North Adams, Mass.

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CHECK THESE ADVANTAGES OF BLANCHARD GRINDING

- ★ **Production**
- **Adaptability**
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- ★ **Operation Saving**
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- **Fine Finish**
- ★ **Flatness**
- ★ **Close Limits**

★ . . . . . *Especially valuable on jobs like the one illustrated.*

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Semi-Steel
Stock per side 1/8"
Limits ±.005"
square .001"
to .0015" in 16"

No. Sides 6
1 piece (6
surfaces)
1 hour and
35 min.

THE SHAPER TABLE, 15½" x 16" x 16", illustrated here, is an excellent example of large, heavy work which may be ground with ease on a Blanchard No. 18 Surface Grinder with 6-inch extended column. These tables come to the Blanchard as rough, semi-steel castings. Six sides are ground, 1/8" stock being taken off each side.

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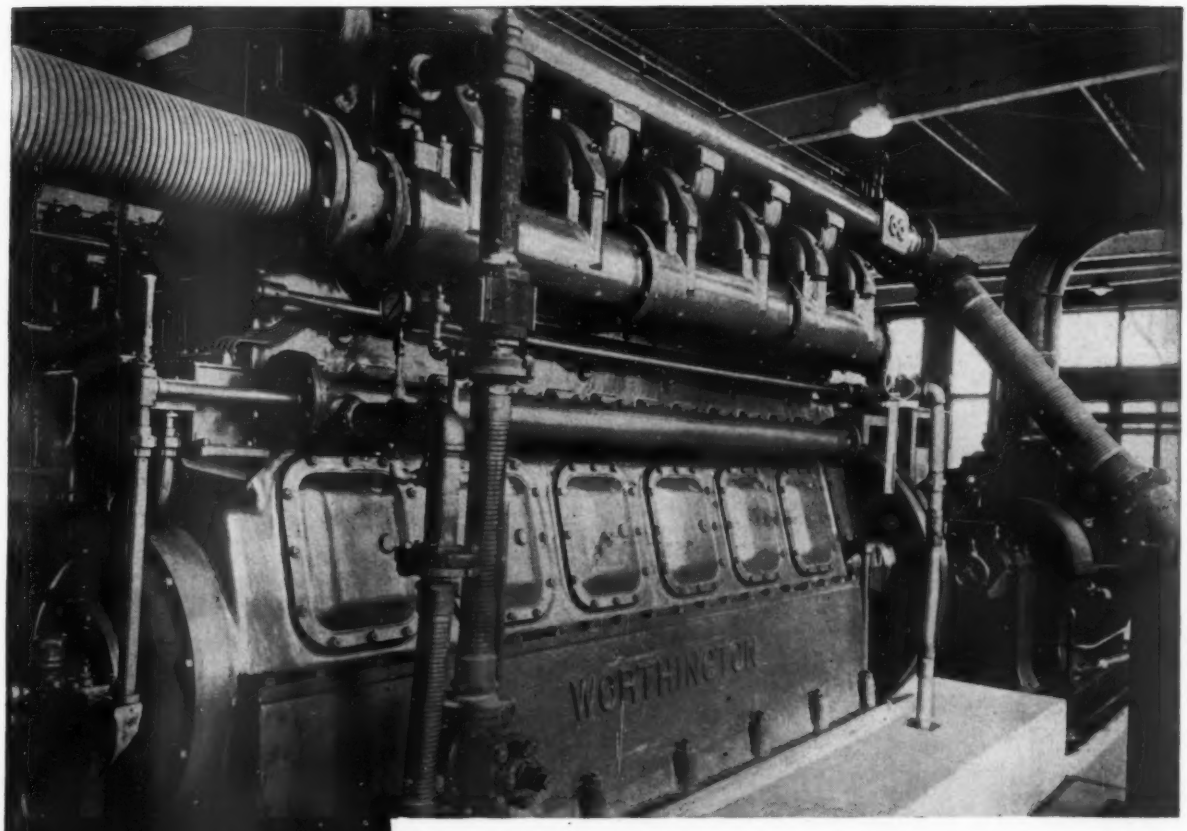
Send for your free copy of "Work Done on the Blanchard." This book shows over 100 actual jobs where the Blanchard Principle is earning profits for Blanchard owners.



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Uninterrupted Service and Safety are important factors in generating power for War Production. PENFLEX Metallic Hose with 4-wall interlocking joint construction and 3/8" "come and go" per lineal foot of length is designed for long life, trouble-free service on intake and exhaust lines, oil, water and other connections. It resists thermal and mechanical strains and fatigue . . . it absorbs vibration and provides safe, economical service.

PENFLEX WELD corrugated, jointless Tubing gives leakproof service on fuel oil feed, circulating water, and starting air lines.

Full data in practical diagrammatic form in Bulletin 71.

In sizes 1" to 18" I. D.

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ESTABLISHED 1902

SPEED UP LIGHT TURNING
AS WELL AS GRINDING
with 9" ROTARY MODEL
PERMANENT MAGNET TYPE CHUCK
Transferred easily from machine to machine or machine to bench—especially useful for pieces difficult to hold in chuck jaws. Catalog of full line on request. No Wires—No Heating—No Operating Costs. Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.
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BATH
IRON WORKS
CORPORATION

Shipbuilders and
Engineers

•

BATH, MAINE

THE TABULAR VIEW

Sweet Music. — Why is so little known about starch? Answers to this question, which is of much industrial importance, are suggested (page 363) by RICHARD S. BEAR, Associate Professor of Biophysical Chemistry at Technology, in an illuminating essay reporting recent advances in research. Professor Bear, a graduate of Princeton and the University of California, joined the Institute Faculty in 1941.

Unity. — Co-operation between science and the humanities in bettering mankind's estate was the theme of a penetrating address to chapters of Sigma Xi and Phi Beta Kappa by JAMES B. CONANT, President of Harvard University, which is basis of his essay in this issue of The Review (page 366).

Targets. — Replanning of cities, if it is to be effective, requires agreement on standards. To this end, FREDERICK J. ADAMS, Associate Professor of City Planning at Technology, has been studying questions of the crowding of people on land, tentative answers to which he presents on page 368.

Protection. — The relations between patents and industrial research are analyzed in the concluding portion of a discussion by ROBERT E. WILSON, '16, of recent attacks on the American patent system (page 371). Dr. Wilson's article is drawn from his address as Perkin medalist for 1943.

Tides. — HERBERT S. SWAN, industrial consultant and city planner who has frequently discussed social trends for The Review, is concerned in this issue (page 360) with the ebb and flow of workers and employment.

Light. — Our cover this month depicts crystals of magnesium, of interest not only because the light metal is today of such urgent utility in the war effort but also because these crystals were produced by the direct thermal reduction of dolomite in vacuum, the technique representing the first large industrial application of high vacuum.

SHIPS, GUNS, PLANES, TANKS
PLUS essential goods and services

Yes, America is meeting the challenge here and abroad on all fronts. We know that the fighting front and the home front must *both* be supplied at an ever-increasing tempo. It is with full realization of the need at hand that this firm is perfecting its facilities for handling vital war work and supplying goods and services needed at home.

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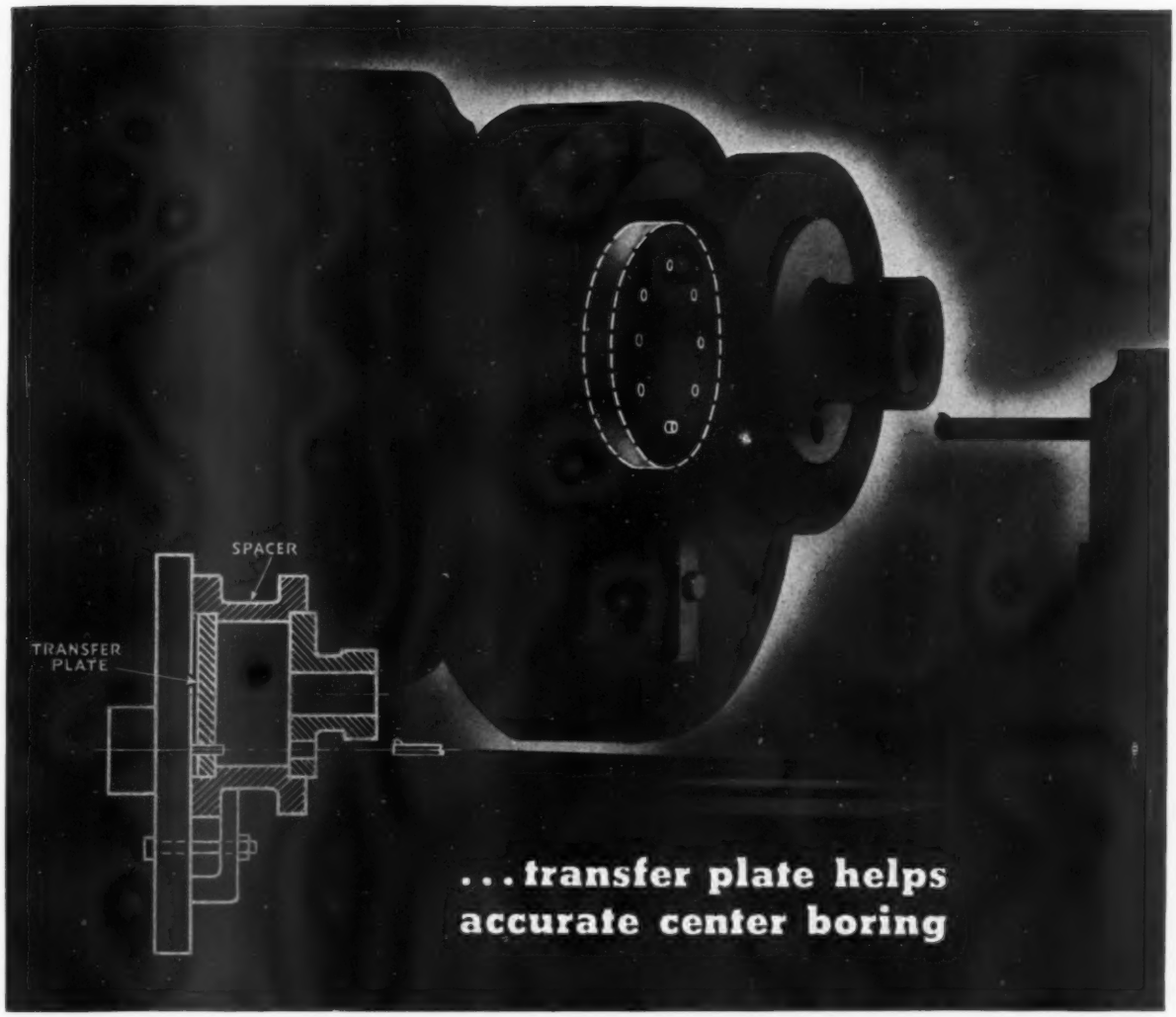

Information supplied by an Industrial Publication

The problem of drilling a number of holes in a part on precise center distances is seldom simple. It is particularly complicated in mass production of parts where holes must register accurately.

The answer in one plant is what is known as a transfer plate. This is really a circular template, of any thickness over ⅛ inch, with uniform holes drilled on accurate centers. These holes fit a pin located at the exact center of a lathe face plate.

In mounting, the work is assembled to the transfer plate with a spacer between. The assembly is pinned to the face plate through one of the holes in the transfer plate, and clamped tight.

A boring bar in the lathe tool rest can be used to bore a hole of any desired size in the work. The hole will be exactly in line with the pin, and consequently with the hole in the transfer plate.

Subsequent holes are bored by passing the pin through the remaining holes in the plate, until all are bored. When finished, every hole, regardless of diameter should be on the same center as the corresponding hole in the plate.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company
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MOLY

HIGH ACCURACY pH EQUIPMENT

SINGLE and MULTI-POINT RECORDERS

Cambridge design insures accuracy and trouble-free performance to a degree hitherto unknown. The Multi-Point Recorder provides *on one chart,* simultaneous records of pH at separate sampling points in the plant. Electrodes (glass) are housed in non-clog continuous-flow type chambers and may be installed wherever wanted. Cambridge is line operated.

CAMBRIDGE pH METERS

Laboratory and Industrial models provide continuous null indication. Sensitive to .005 pH, stable, rugged and portable. Operate from any convenient 110 volt AC. outlet.

Send for Bulletin 910-E

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CAMBRIDGE
PRECISION INSTRUMENTS

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HEVI DUTY
REGISTERED U. S. PAT. OFFICE

Hevi Duty Electric Co.

Electric Furnaces

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Hevi Duty Precision Electric Heat Treating Furnaces are built in a large variety of types and sizes — for many heat treating operations — with temperature ranges to 2500° F. (1371° C.). They are standard production equipment in many national industrial plants.

Write for descriptive bulletins

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District Manager
90 West Broadway
New York

ELTON E. STAPLES, '26
District Manager
205 W. Wacker Drive
Chicago, Ill.

MAIL RETURNS

Stop, Look, and Listen

FROM JUDSON C. DICKERMAN, '95:

In many respects the April Review is a well-balanced issue. I especially like the occasional articles that refer to the long history of man. It may help to keep down our present-day shortsighted egotism. The statements in "The Trend of Affairs" emphasizing the value of authentic anthropological studies as guides to our present and future relations with the races of mankind, possessed of diverse environments and traditional attitudes engendered thereby, are good stop, look, and listen signs.

Today we are hearing again much about marvelous inventions, new products, and so on, to be released as soon as military conditions permit. I seem to remember much the same order of prognostications during the 1914–1918 period. I'm just wondering if some competent person of your staff might not throw interesting light on this subject of how much a mass of people is apt to be affected by a horde of new devices. After all, many new things are only substitutes for other things that must be discarded. The standards of living are not advanced by the adding of the new on top of the old. There is a loss as well as a gain.

A review of the important changes which followed the great stimulation of invention, and so on, of 1914–1918 and which really affected the people as a whole, say within 10 years after that period, might help keep our feet on the ground.

Chevy Chase, Md.

An Old Friend

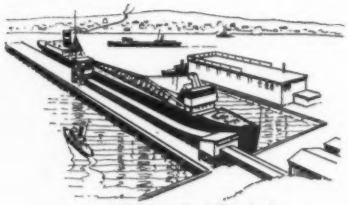
FROM CAPTAIN REGINALD A. BISSON, '30:

Reading The Review for November was like meeting an old friend until I chanced to glance through the list of my classmates serving with the armed forces of the United States and found that I'd been overlooked entirely. Tsk and tsk! Despite my natural inconspicuousness and wholly undistinguished service, I'm sure my son and daughter wouldn't like to see their daddy's name omitted that way. . . . So, "Correction, please?"

I could give you an earful about what some of the aforehereinmentioned classmates are doing, but nobody knows whose curious ears (or eyes) would get in the way first. Hence discretion and appreciation of the need for and value of such things as censorship preclude any lengthy statement on that subject. Suffice it to say that the Institute can and should be mighty proud of most of 'em. . . .

A.P.O. 682, Care of Postmaster, New York, N. Y.

Speed with Economy



Old Colony Coal Terminal

In our 25 years of industrial building, we have erected factories, warehouses, power plants, coal handling terminals, bulkheads, special tanks, etc. This wide range of experience may prove valuable to you.

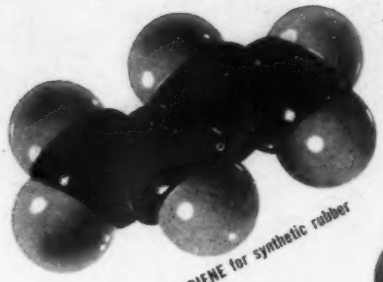
W. J. BARNEY CORPORATION

101 PARK AVENUE, NEW YORK

INDUSTRIAL CONSTRUCTION

Alfred T. Glassett, '20, Vice President

ACETONE for rayon, photo film; solvent



BUTADIENE for synthetic rubber

ETHYL ACETOACETATE for life-saving drugs, vitamins

ETHYLENE GLYCOL for dynamite, anti-freeze, aircraft engine coolant

ETHYL ALCOHOL for lacquers, pharmaceuticals, smokeless powder

ETHYLENE DICHLORIDE for vitamins, anti-knock fluid, plastics, insecticides

Molecular Keys To A New World

VAST NEW SOURCES of raw materials . . . the equivalent of those which might be found in a great new continent . . . opened to America when CARBIDE AND CARBON CHEMICALS CORPORATION, a Unit of UCC, started building synthetic chemicals from water, salt, air, and hydrocarbons.

These chemicals are usually water-white liquids, although some are gases or solids. Basically, they are compounds of carbon and hydrogen—united with oxygen or with chlorine to build up an endless series of chemicals. The models of those molecules of chemicals shown here are many millions of times actual size.

These chemicals are the raw materials for fabulous plastics . . . amazing textile fibers . . . life-saving drugs . . . vitamins by the carload . . . synthetic rubber . . . more things and better things than were possible before their existence.

Since these chemical wonders are obtained from abundant domestic sources, their use has contributed materially to the nation's self-sufficiency. Through research, American ingenuity, and patient development, scarce natural products have been duplicated or improved upon. Great new industries and great new materials that contribute to the nation's strength have come into being. And America has become a leader in a field as native as its own soil.

Broadly speaking, the uses of many of the synthetic organic chemicals developed by CARBIDE AND CARBON CHEMICALS CORPORATION are just beginning. The already established uses are indicative of their vast future values to mankind.

BUY UNITED STATES WAR BONDS AND STAMPS

BETTER MEDICINES! Amazing medicines like the sulfa drugs, synthetic vitamins, powerful insect repellents, and anti-malarial drugs depend upon synthetic organic chemistry.

COLD PROOF! Coolant for liquid-cooled aircraft engines and base for anti-freeze in military cars and trucks is ethylene glycol, an important synthetic chemical.

MAGIC PLASTICS! Wonderful plastics that look like glass, stretch like rubber, and which are proof against water, sunlight, oils, and many chemicals are made from VINYLITE synthetic resins.

MAN-MADE! All types of synthetic rubber require synthetic organic chemicals for their manufacture. Here's hope for tires for you in the future.

UNION CARBIDE AND CARBON CORPORATION

30 East 42nd Street UCC New York, N. Y.

Principal Products and Units in the United States

ALLOYS AND METALS
Electro Metallurgical Company
Haynes Stellite Company
United States Vanadium Corporation

CHEMICALS
Carbide and Carbon Chemicals Corporation

ELECTRODES, CARBONS AND BATTERIES
National Carbon Company, Inc.

INDUSTRIAL GASES AND CARBIDE
The Linde Air Products Company
The Oxweld Railroad Service Company
The Prest-O-Lite Company, Inc.

PLASTICS
Bakelite Corporation
Plastics Division of Carbide and Carbon Chemicals Corporation

Trail Blazing in the Skies

1920

THE FIRST BULLET-PUNCTURE-SEALING GASOLINE TANK for military airplanes was developed by Goodyear at the close of World War I. After exhaustive tests it was adopted by the Army Air Corps and Goodyear was officially commended in 1920 for its invention. That is a matter of record, as was its effectiveness in sealing punctures made by the small-caliber armament then carried by planes.

1943

AS A RESULT OF THIS EXPERIENCE, Goodyear is today building bullet-puncture-sealing tanks that self-close punctures made by modern heavy-caliber ammunition which rips jagged, flaring holes in ordinary metal tanks. So swift is this sealing action, very little gas is lost and the danger of fire from incendiary bullets is greatly reduced. Goodyear supplies all types and sizes of these tanks to fit the varying needs of both fighter and bomber planes.

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE AVIATION INDUSTRY

1. *By building parts to manufacturers' specifications.*
2. *By designing parts for all types of planes.*
3. *By re-engineering parts for mass production.*
4. *By extending our research facilities to aid the solution of any design or construction problem.*

GOODYEAR

GOODYEAR AIRCRAFT

VOLUME 45 NUMBER 7

THE TECHNOLOGY REVIEW

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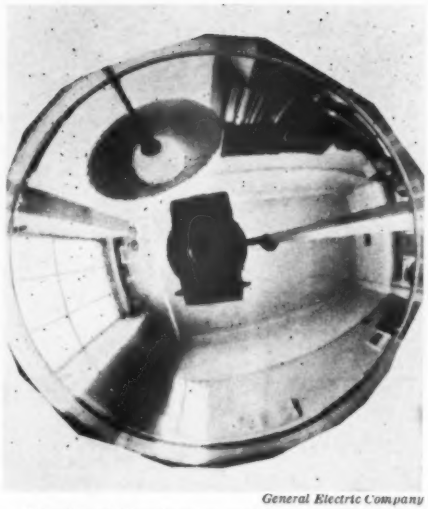
EDITED

AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY



General Electric Company

Solution of illumination problems is speeded by a recently developed "fisheye" camera which photographs reflections in a convex mirror calculated to show the area of extended light sources in exact proportion to the amount of light received from them by a surface at the location of the mirror.

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From a photograph published by special arrangement with the National Research Corporation

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Relating to the Massachusetts Institute of Technology

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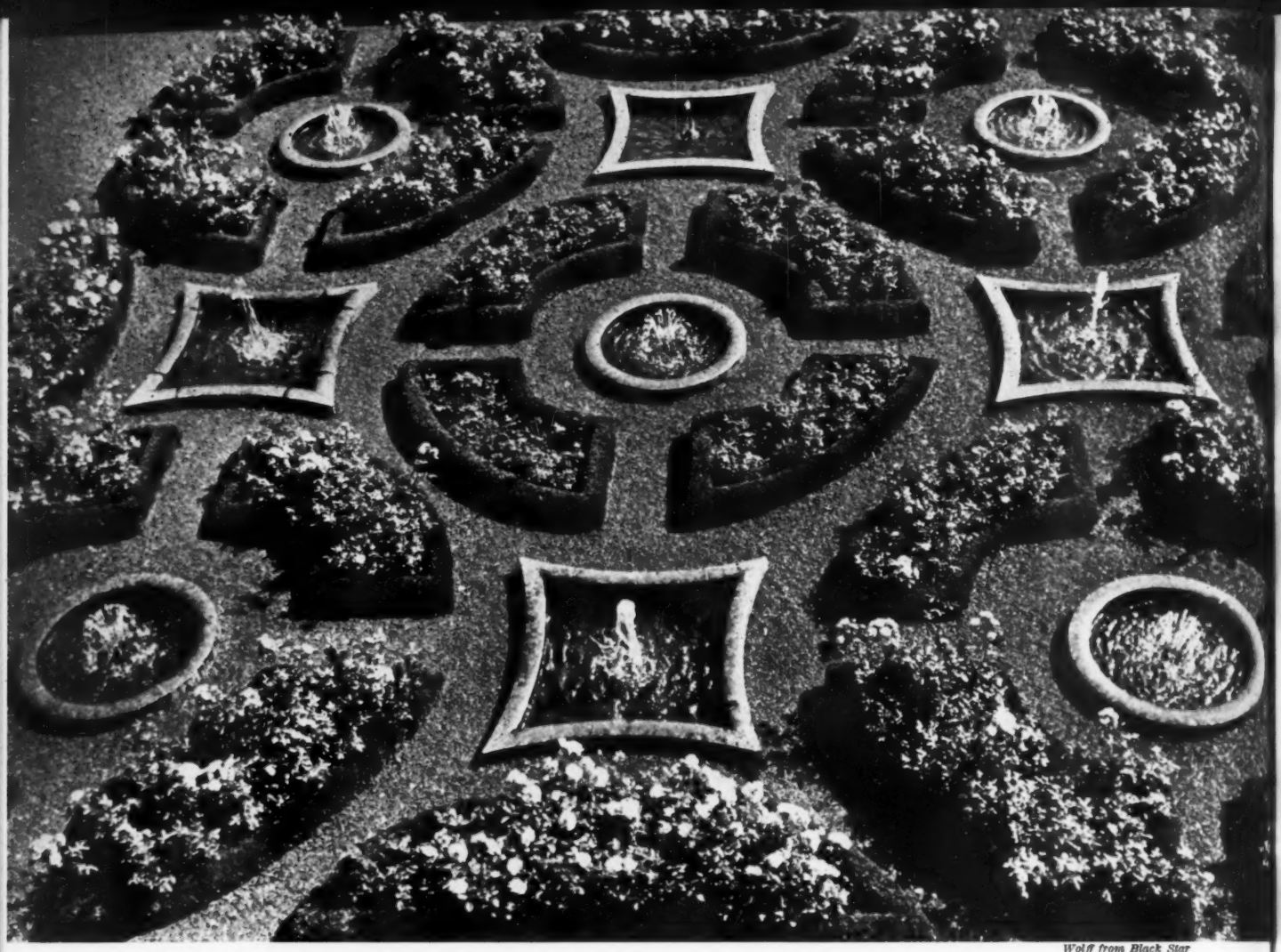

Wolff from Black Star

Spring, as a castle garden in Silesia once formalized it

THE
TECHNOLOGY
REVIEW

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The Trend of Affairs

The New Old

THERE is always something new under the sun — at least, as far as socially desirable scientific research is concerned. At present, of course, many such projects are in abeyance because they cannot be directly related to the main task of winning the war. Among these deferred undertakings — not a few of which should be considered deferred obligations — one of the greatest urgency is that presented by the new old. Study of this problem merits the highest of priority among research to be resumed as soon as possible, for the new old exert already and will increasingly exert important influences upon the industrial, economic, and social aspects of our civilization.

The new old are people. Old people as such are nothing new. But old people in larger and larger proportion of the total population are decidedly new. From 1930 to 1940, the number of people 65 or over in the United States rose from 6,633,805 to 8,956,206 — an increase of 35 per cent as against an increase of but 7.2 per cent in the total population. During that same decade, the median age of the population of the United States increased from 26.4 to 28.9 years. Measured over a longer span, the figures continue significant: In 1900, people 45 years or over made up 17.8 per cent of the population of the country; in 1940, they constituted 26.5 per cent. Estimates of the Bureau of the Census, which assume no net immigration and assume continuation of present trends, foresee 40.4 per cent of the total population in 1980 as being 45 years or more in age. These figures are representative of the results of preventive medicine, sanitation, and greatly improved pediatrics. Prevention and better treatment of infective diseases, and better diet, have led to the increase of average life expectancy at birth from the 47 years of 1900 to the better than 62 years for white races at present.

Prime Minister Churchill put the problem in these terms recently: "In 30 years, unless present trends alter, a smaller working and fighting population will have to support and protect nearly twice as many old people; in 50 years the position will be worse still." A declining birth rate in Great Britain, which he declared to be "one of the most somber anxieties which beset those who look 30 or 40 or 50 years ahead," occasioned his statement of the problem. Recent Census Bureau announcement of an upswing in the birth rate in the United States — population gain during 1942 was at nearly twice the average annual gain for the decade 1930–1940— is properly discounted on the ground that such increases are wartime phenomena, reflecting business prosperity and expected conscription. With the return of peace, restoration of the trend upset by this reversal may be foreseen, if indeed restoration of it does not occur earlier as a result of the dislocation of population attendant upon war.

The problem which the new old present, and for solution of which a broad program of gerontological research is needed, is not only that of forestalling the enormous economic cost to society which may otherwise be encountered. In the swiftly increasing reservoir of older people are great stores of wisdom, of skill, of judgment, of strength, the benefit of which society needs. Hence coherent and co-ordinated study of aging, study of the physical and mental aspects of normal senescence and senility, and study of the diseases, physical or mental, characteristic of the senescent period are important, the more so when one recalls that no such broad and thoroughgoing work has been done in geriatrics as in pediatrics, at the other end of man's span. Beyond the medical phase of the problem lie manifold socioeconomic questions which must be resolved both for the new old to be assured their rightful enjoyment of their own years and for society as a whole to be best served.

Walt Sanders from Black Star

Steam and smoke as towboats do their work

Inventorying the Labor Asset

BY HERBERT S. SWAN

UNREST among workers is a protest against inefficiency and waste in the utilization of labor. This fact is too frequently overlooked. Employees are regarded too much as auxiliaries of machines; emphasis is laid upon profitable employment of mechanical equipment rather than upon continuous employment of workers. Yet the latter measures the efficiency of industry not less, if indeed not more, than does the former.

Information upon the accession rate to employment, the recession rate from employment, the normal expectancy of employment, and the severance rate for different age groups — the basic yardsticks necessary for gauging the full employment of labor — should prove particularly valuable in solving labor problems in the postwar period. For this reason, data compiled by the Social Security Board portend much for the future; in effect, they implement our technique in striving for worth-while social objectives with a new tool. Statistical tables presented by this board, when worked up into new relationships, yield for the first time some vital facts relative to the labor asset in both state and nation.

For example, to maintain a peacetime labor force of 1,000 men apportioned among various age groups as males are apportioned in the entire labor force throughout the country, net over-all accession rates based on 1937 figures show that in each five-year period a manufacturer must hire 167 men. Two of these would be under 15 years of age; 75 would be between 15 and 19 years; 90, between 20 and 24 years. A work force of 1,000 women distributed in the same manner demands the employment of 252 girls every five years, slightly more than one-half again as many girls as men. Only one girl would be under 15, whereas 132 would be between 15 and 19, and 119 would be between 20 and 24. Such was the picture before war drained off millions of men of accession ages and sharply shifted the accession age of women. A major problem of the postwar years may well be how to bring employment tables back from their present unusual aspect and to improve upon past standards. The recession rate for various age groups by five-year periods is of equal importance with the accession rate. Table 1, based on the figures of the Social Security Board, shows the two rates:

TABLE 1

Accession Rate per 1,000 Employees in Five-Year Periods

Age	*1,000 Employees*	*1,000 Male Employees*	*1,000 Female Employees*
–15	+ 2	+ 2	+ 1
15–19	+ 90	+ 75	+132
20–24	+ 98	+ 90	+119
Total	+190	+167	+252

Recession Rate per 1,000 Employees in Five-Year Periods

Age	*1,000 Employees*	*1,000 Male Employees*	*1,000 Female Employees*
25–29	– 23	– 8	– 65
30–34	– 30	– 20	– 56
35–39	– 24	– 21	– 32
40–44	– 18	– 15	– 24
45–49	– 16	– 15	– 20
50–54	– 21	– 21	– 21
55–59	– 18	– 20	– 13
60–64	– 16	– 18	– 10
65–69	– 21	– 25	– 10
70+	– 3	– 4	– 1
Total	–190	–167	–252

The accession rate is principally important in what it shows as to the entrance age of new employees; the younger the entrants, the less well they are equipped to enter employment. The longer employment is deferred, provided the delay is utilized in getting added knowledge and vocational training, the better the applicant is equipped to assume responsibility and, therefore, to earn higher wages. Communities which graduate children at 15 years of age directly from elementary schools into business are, as a consequence, likely to remain regions with a rather elementary technique and low adaptability to changing requirements of industry.

The recession rate represents a minimum basic turnover rate in labor. Taken in conjunction with the accession rate, it affords a rough approximation of the average length of time a new entrant may be expected to continue employed, with his several employers taken collectively. When normal expectancy of employment is comparatively brief, the employer assumes a disproportionate expense in training new help.

Suppose a plant hires 1,000 new entrants into employment: How many will continue at work in each quinquennium? How many will be lost as a result of all causes? Table 2 gives the answer to these questions in terms of normal pre-war experience. It is based upon Social Security Board data and shows accession and recession rates per 1,000 new employees hired in the United States in 1937:

TABLE 2

Age	Accession Rate per 1,000 Employees: 1,000 Employees	1,000 Male Employees	1,000 Female Employees	Distribution of 1,000 New Employees Hired: 1,000 Employees	1,000 Male Employees	1,000 Female Employees
−15	+ 10	+ 12	+ 4	10	12	4
15–19	+ 474	+ 449	+ 524	474	449	524
20–24	+ 516	+ 539	+ 472	516	539	472
Total	+1,000	+1,000	+1,000	1,000	1,000	1,000

Age	Recession Rate per 1,000 Employees: 1,000 Employees	1,000 Male Employees	1,000 Female Employees	Survivors of Original 1,000, End of Quinquennium: 1,000 Employees	1,000 Male Employees	1,000 Female Employees
25–29	− 120	− 48	− 258	880	952	742
30–34	− 160	− 120	− 222	720	832	520
35–39	− 124	− 126	− 127	596	706	393
40–44	− 95	− 89	− 96	501	617	297
45–49	− 85	− 90	− 79	416	527	218
50–54	− 110	− 126	− 84	306	401	134
55–59	− 95	− 120	− 51	211	281	83
60–64	− 84	− 107	− 39	127	174	44
65–69	− 111	− 150	− 40	16	24	4
70+	− 16	− 24	− 4			
Total	−1,000	−1,000	−1,000			

The severance, or recession, rate is a law unto itself in each community. One would presume that it would increase with each successive age group. But curiously it is smaller for some intermediate than for some lower age groups. The fact that the recession rate for men between 45 and 49 is less than that between 35 and 39, and that the rate for women between 45 and 49 is appreciably less than that between 30 and 34 raises the question whether industry, in concentrating employment within low age groups, may not contribute to the unsettlement of the labor market, to industry's own disadvantage. In working against such concentration, the dislocations produced by the war may, strange as it may seem, exert a stabilizing influence upon employment.

As the ease of developing a skilled personnel in business increases directly with the normal expectancy of employment, so the cost of training workers up to a desired standard of skill increases with the rapidity at which replacements must be made to maintain personnel. Here again the accession and recession rates offer interesting data. Normal expectancy of employment in the country as a whole for both sexes is about 26.3 years; for males alone, it rises to 33 years; for females alone, it is only 20 years. In different states the average varies widely — for men, from 22.8 years in South Carolina to 33.6 years in New York; for women, from 16.5 years in North Dakota to 24.6 years in Maine. The effect of such differences is that an employing organization, in order to maintain a labor force of 1,000 men with the same age distribution as that of its state, has annually to employ only 29.8 men in New York as against 43.8 in South Carolina. For every 100 new men hired in New York to replenish the force, 147 would have to be hired in South Carolina. A high turnover rate measures the inefficient use of labor.

Many maladjustments in employment have been due to lack of data showing blacked-out areas in the labor market passed over in the current use of labor. As a result of inadequate information, business may concentrate demand for labor within limited age groups of either or both sexes and so create acute shortages in particular sectors of the market while at that very moment an abundance of workers, in a different age or sex group, may be seeking employment. Study of accession and recession rates should help to direct enterprise intelligently into unexploited sectors of the employment structure and should prove especially useful in meeting the difficult readjustment necessary after the war.

Roy Pinney from Black Star

Moonlight and gentle breeze as the schooner comes in

Hold with Hope

THE shortest air route from Seattle to Moscow lies over Greenland. That from New York to China lies over Alaska. Air power is putting a new aspect on geography, a truly global aspect that no map based on the Mercator projection can convey. Because of the airplane's ability to fly great circle routes indifferent alike to land and water barriers, arctic lands are increasing in importance both strategically and economically.

Americans are therefore taking a new interest in Denmark's Greenland, the largest European-held area in the Western Hemisphere and the largest island in the world. Denmark's title to it is as strong as any small nation's could well be: In 1916, when purchasing the Virgin Islands from Denmark, the United States formally relinquished all claims to the land in northern Greenland which Peary had discovered, and in 1933, after a dispute between Denmark and Norway over eastern Greenland, the Permanent Court of International Justice confirmed Denmark's title. As for western and southern Greenland, Denmark in recent decades has there performed one of history's outstanding examples of humane and intelligent colonial administration. Apropos of these well-known and doubtlessly dull data occurs the possibility that if the airplanes of the post-

war world are going to flit about over Greenland's rather astounding scenery, we may see the opening of new meccas for tourists (and this applies to other lands), as areas requiring the utmost fortitude to reach by land or sea become reasonably accessible by air. One such area may be the fiord region of east Greenland — the largest, the most complex, and, if the camera does not lie, the most awe-inspiring system of fiords in existence.

To date, this region lying between 70 and 74 degrees north has been visited almost exclusively by people with a strong professional reason for going there — explorers, whalers, and scientists — and then almost invariably during Greenland's short summer. A belt of pack-ice guards the coast during the rest of the year, and although Stefansson argues to the contrary, many travelers regard the east coast of Greenland as inaccessible by sea at that time. The west coast — that facing Canada — is much easier to reach, and some harbors to the southwest are free from ice all year. It appears possible, however, to land planes on the icecap of interior Greenland and on the still water of the fiords when they are clear of ice.

Some of the fiords of the east Greenland coast penetrate for hundreds of miles into a high plateau and may well extend much farther back from their present heads, completely covered by ice. Many of the fiords seem to be valleys scoured out by tremendous ice rivers fed by the deep icecap that covers the entire interior of Greenland to a depth of many thousands of feet. Scoresby Sound, the world's longest fiord, is 186 miles long and at some points almost a mile deep. Farther north lies the Franz Josef Fiord, the upper end of which has been likened to an arm of the sea half a mile deep lying in the bottom of the Grand Canyon. One feature of this latter fiord is an enormous granite cliff which shoots up from the water in a steep curve to almost 6,000 feet. Appropriately, this precipice bears the name "Attestupan," which in Viking mythology is the cliff over which those tired of life through old age, sickness, or any other reason flung themselves to death.

Greenland has been known to the world for a surprisingly long time. Because of its closeness to Europe, it was visited and settled by white men long before any other part of the Americas had been seen. The east coast, however, was apparently as unattractive for settlement to the whites as to the Eskimos, and only legends remain of the various Vikings, Irishmen, and Icelanders who may have seen those shores during the Middle Ages. Many whalers saw the fiord region during the Seventeenth and Eighteenth centuries. Indicating the frequency of these visits is the fact that in 1777 almost 50 whaleships were crushed in the ice, with over 400 men eventually perishing. The Nineteenth Century witnessed the beginning of more accurate exploratory work which, with fewer and fewer interruptions, merged into the detailed and multifaceted investigations of the present day.

But the greatest name in the exploration of the fiord region is still that of Henry Hudson, who in 1607, attempting to reach Cathay by sailing across the North Pole, sailed up the east coast of Greenland as far as 73 degrees 30 minutes north. There he sighted a range of high hills and called them, in vigorous Elizabethan English, "Hold with Hope," a name that can well be taken as a motto by all nations with arctic possessions.

Mars, Merchandiser

That values shift in time of war is a truism often newsworthily illustrated these days. Bolstering data range from those asserting the prime virtues of the salvaged tin can to those emphasizing to schoolmasters that one of the nation's serious shortages is of men who can write clear, direct English about the techniques essential to winning a war of machines and instruments. The latter situation is worth the passing remark that Mars himself is in considerable measure to blame for it. It was the first World War that succeeded in breaking down once and for all the tradition of hardheaded newspaper anonymity which focused everything on plain factual writing — objective "straight reporting" was the term — and in replacing it with first-person signed stories, precursors of book after book on such subjective topics as how it feels to be the son of a rural dogcatcher. This sort of thing as a literary mode is all very well, but it is not calculated to foster good writing about how to net an obstreperous cur or, in fact, how to do much of anything else.

But we are here concerned with far less subtle shifts of value — interested, rather, in the fact that milkweed floss and cattails are articles of commerce and that the lowly mussel of the Maine Coast, being packed as lend-lease food for shipment abroad, has become basis of an industry.

The life belts and floats that once were stuffed with kapok now rely on the silky floss of the milkweed — 50,000 pounds of it were so used last year. Entire output of the processing plant established by Dr. Boris Berkman, a Russian military surgeon in the first World War, has been taken by the government. The seed which are separated from the floss have been found to be the source of an oil resembling soybean oil in properties and possible uses. The pod shells and the stalks may provide other by-products. Land too poor to support anything else finds its value augmented by this demand for milkweed; farmers who picked pods last year for the factory earned from four to seven dollars a day.

The floss of the ubiquitous cattail — remember how aesthetic maiden aunts used to gild them with radiator paint? — is used for the same purposes as is the milkweed floss — for life belts and floats, for insulation of heat and sound, for padding and filling. Cattail floss, it is reported, can compete with cotton on the basis of cost per pound.

Mussels, which West Coast Indians ate with relish early in the last century, rejecting the clams which their East Coast contemporaries preferred, are being packed in jars and cans, fresh frozen, or shipped fresh. They are said to be of richer flavor and higher food value than clams, and can be gathered with less equipment and trouble. Maine fishermen are expecting to take 200,000 bushels this spring, which will be the largest crop in United States history. Mussels, which are plentiful along the Maine Coast, were formerly used only for bait.

Cinderella Starch

Increasing Knowledge of Its Structure and Properties Is Expected to Make the Starch Molecule of Greater Use in Chemical Industries

By Richard S. Bear

AMONG the family of organic raw materials is one which, like the legendary Cinderella, is kept close to the humdrum affairs of life and is not often allowed into the more romantic, hence lucrative, processes of chemical industry. This Cinderella is starch. Recently an executive of the starch industry was heard to lament that his product, aside from its uses as food, is too often only a filler or binder for other substances and as such escapes the limelight of industrial attention and esteem.

One of the reasons for this situation is that of economy. The "stepsisters," or chief competitors, of starch are cellulose and petroleum. On the basis of dollar-a-bushel corn, starch is available at about two cents a pound as compared to four cents for wood cellulose of comparable purity. Petroleum, however, costs normally about half a cent a pound and hence has an initial advantage over the two carbohydrates. Nevertheless, all three raw materials may be regarded as cheap enough so that processing costs may decide in some instances which material is to be employed.

In spite of the cost handicap that hinders starch in its competition with petroleum, our chemical Cinderella may come into her own sooner than might have been expected, unless rumors that present oil shortages are not merely temporary shall prove to be false. Both of the carbohydrates, cellulose and starch, come from an annually replenished source of supply, so that in using them we are living upon an inexhaustible income rather than wasting our capital resources, which petroleum supplies must be regarded to be.

In the meantime, the "fairy godmother" planning for the future of starch is the industry most intimately connected with the production of it. Two-thirds of the solid matter obtainable from the corn grain is starch; hence the interest of the corn industries in Cinderella is understandable. Many of the common problems in pure and applied science which these industries face are the chief concern of the Corn Industries Research Foundation, which is maintained jointly by the interested companies. Norman F. Kennedy, director of research for the foundation, has expressed his organization's chief problem as follows: "In recent years the industry has become certain that its future expansion will depend largely on the chemical uses which can be developed from starch as an organic raw material."

Starch has in the past seen no inconsiderable application to various industries, such as those producing food, paper, and textiles. Outside of the food applications, however, most of these industries employ only certain of the physical properties of starch which make it suitable for sizing, filling, binding, or other operations that might in general be termed colloidal applications. To this end only mild chemical alterations of the starch molecule are ordinarily introduced.

The future looks to the employment of more drastic chemical modifications of starch. Anticipated are a host of chemical products, most of them obtained by way of simpler molecules, commonly those of the corn sugar, dextrose, or of grain alcohol and other less well-known alcohols. Substances of present-day importance, such as vitamin C and synthetic rubber, are in this list. Many of them now, however, are to be regarded as possibilities rather than commercially proved actualities.

From another point of view, the treatment of starch as a neglected "stepchild" of industry may be taken as an example of the fact that what man does not under-

Science News Letter

One of Cinderella's dwelling places. Two-thirds of the solid matter obtainable from corn grain is starch.

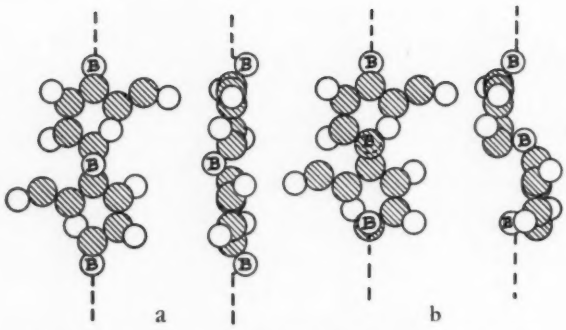


Fig. 1. Models showing both front and side views of the molecular chains of cellulose (a) *and starch* (b) *in the maximally extended condition. The complete molecular chain of each can be visualized as resulting from a multifold repetition, along the dotted lines, of the two adjacent dextrose units actually depicted. Shaded circles represent carbon atoms; open circles, oxygen. Hydrogen atoms, which are present but not involved in the chain "skeleton," are omitted to avoid confusion. Dextrose units are joined by the oxygen atoms marked* B. *The spatial relation between each of these bridging atoms and the carbon atom next above it along the chain direction of the figure determines many of the differences between cellulose and starch.*

stand very well he is incapable of effectively utilizing. The story is told that some years ago in celebration of a birthday anniversary of the great chemist, Emil Fischer, his students staged a playlet in which various simple sugar molecules were personified and put through paces illustrative of their chemical reactions. Starch was represented only by sweet music off stage, reflecting the mystery attached to it.

Throughout the history of scientific investigation of it, starch has presented especially puzzling problems which have retarded the attainment of any very complete understanding of the diverse phenomena that it presents. Notwithstanding the difficulties, recent years have finally been marked by great advances in our knowledge. Some of this fascinating story is told here, with an attempt to indicate as non-technically as possible the main paths along which progress has been attained.

CELLULOSE and starch, both plant products, are very much alike chemically, consisting of long chains of ring-shaped sugar (dextrose) molecules joined together by bridges consisting of an oxygen atom each. Starch differs from cellulose in the precise spatial arrangement of the bridging oxygen atoms, a small difference which is nevertheless very important in determining their respective properties (see Fig. 1). Cellulose molecules may be thought of as long ribbons, since the cellulose bridges permit dextrose rings to lie pretty much in one plane. The starch chain is a puckered ribbon, because adjacent dextrose molecules are not permitted by their bridge to extend in the same plane. In addition, a certain variety of starch molecule possesses branched chains, with occasional dextrose units attached to more than the usual two neighbors.

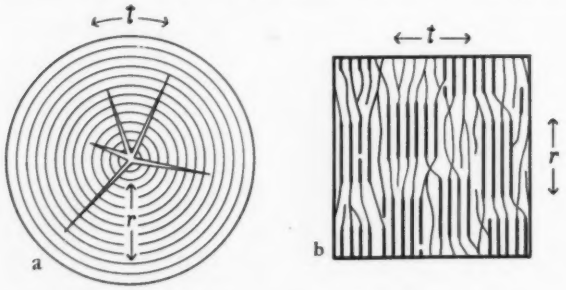


Fig. 2. Diagrams of a starch granule (a), *with layered structure and radial fissures, and of a highly magnified portion of a layer* (b), *showing ramification and interweaving of chains, which tie together more regular "crystalline" regions. The latter are represented by heavy lines. Arrows marked* r *and* t *show respective radial (or longitudinal) and tangential (or lateral) directions, as these terms are employed in the text.*

Of equal importance with the precise knowledge of the chemical nature of starch is some conception of the way in which individual chain molecules become contorted or aggregate, for it is in the variety of forms they are capable of assuming that the starch molecules present their bewildering array of aspect. This phase of the subject forms the present story.

While cellulose serves as the skeletal material of plants, starch forms the reserve food supply, distributed widely through each plant but particularly stored in seeds and in roots or tubers. In green parts of the plant, the starch granules are closely associated with the green chloroplasts, where the important phenomenon of photosynthesis occurs. The starch granule possesses, therefore, a very close relation to the primary processes by means of which the sun's energy is converted and stored in a chemical package.

The starch granule is the form in which man, so to speak, mines this product from natural sources — fruits, seeds, and tubers. Refining processes separate the extraneous plant structures and leave the small, spherical (corn), disk-shaped (wheat), rodlike (banana), or egg-shaped (potato) particles, which are small glass-clear beads a few ten- or hundred-thousandths of an inch in diameter. These constitute the powders of commercial corn, potato, or other starch.

The scientist begins his attack on the starch structure with the granule. By ordinary microscopic observation he can see that the granule possesses a faintly visible layered structure, similar on a small scale to that of an onion, the layers of a pearl, or the annual rings of a tree. In fact, he feels that diurnal periodicity in the growth of the granule is responsible, since these layers are not produced when plants grow under constant illumination. Fundamentally, therefore, the layers are not very significant.

More important is the observation that when attempts are made to crush the granule, or when the granule is excessively dried, it has a tendency to split radially, i.e., along lines from the center to the periphery, as shown in Fig. 2*a*. Study of the granules with polarized light makes plain why this radial splitting occurs. With polarized light the granule can be shown to have the ability to refract doubly, or to "bend" light, and the way in which this double refraction occurs points to the conception that the long, chainlike starch molecules are oriented radially in the granule. These molecular chains are more easily parted from each other laterally than broken longitudinally; hence the development of the radial rifts.

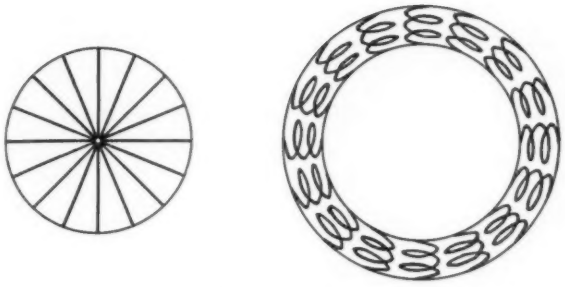


Fig. 3. A model to illustrate the mode of expansion of a starch granule during gelatinization. On the left is the original granule with radially extended molecular chains. After gelatinization these have contracted and thickened, as shown on the right, to increase peripheral area and develop an interior cavity, which becomes filled with fluid drawn in from the environment.

X-rays, another of the scientific agents useful in studying the fine structure of materials, add more details to the story. Since the starch granules diffract x-rays nicely, the parallel molecular chains must, at least along parts of their lengths, be arranged with a regularity of structure surpassing that of simple molecular orientation. In other words, occasionally in local regions of submicroscopic size the parallel chains enter into crystalline perfection of arrangement.

The regularly repeated atomic spacings of the crystalline regions of the granule, however, extend over domains small in comparison to what the length of an individual starch chain may be expected to be. With this fact in mind, it is concluded that one chain may be a part of a number of crystalline regions, thus serving to tie these together (see Fig. 2*b*).

The entire granule, then, is a network of little crystalline portions tied together by ribbons of starch chain. As a consequence, it has a rather compact structure and resists penetration into its interstices by what the chemist calls nonpolar (oil-loving) solvents; only those described as polar (water loving), such as water itself, can enter and cause chemical reactions, alterations in physical properties, or changes in volume.

The relations of starch and water are particularly important, as the x-ray diffraction patterns also show.

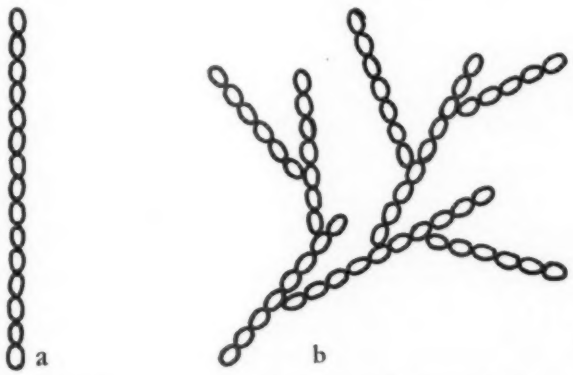


Fig. 4. Diagrams representing the difference between molecules of amylose (a) *and amylopectin* (b). *Each oval is a dextrose unit. Actually the real molecules possess many more units (see text).*

If the distinct crystalline starch patterns are to be obtained, the moisture content of the granules must not be too low. In this respect, starch granules behave like simpler crystalline hydrates. The inference is that water molecules form an important part of the starch crystal, perhaps serving to associate the starch chains laterally.

Diffraction patterns of different types of starch granule — for example, those of the cereal grains as distinguished from those of tubers (potato) — show variations that parallel roughly some of the industrially significant properties of the granule types. Under appropriate conditions, one crystalline modification of the granule can be changed into the other, with a corresponding alteration in granule properties. Such changes offer the possibility of converting one, perhaps inexpensive, granule type into another with more desirable characteristics normally possessed by material of greater value.

PERHAPS the most striking of all phenomena exhibited by starch granules is their capacity to act as self-inflating balloons, to which process the starch chemist applies the name "gelatinization." When heated

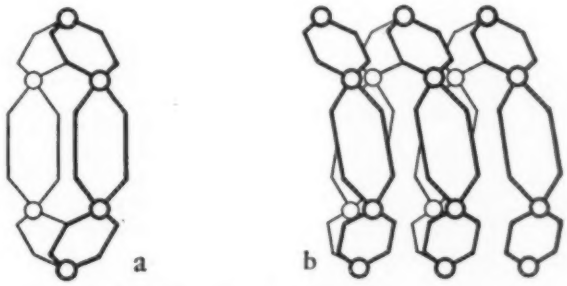


Fig. 5. Side views showing the relationship between the ring-shaped cyclo-hexa-amylose molecule (Schardinger a *dextrin),* a, *and a portion of a starch chain helix,* b. *The hexagons represent dextrose units, joined at opposite corners by circles, or oxygen bridges. Heavy lines indicate units extending before the plane of the figure, light lines those behind this plane.*

in aqueous suspension (80 to 100 degrees Centigrade), granules of each type at a characteristic temperature begin to expand and continue to do so until volumes of perhaps more than 40 times the original are attained. In the end, each granule appears as a thin-walled sack containing a dilute starch solution. Because of the great increase in volume, relatively dilute granule suspensions after gelatinization find swollen sack walls in contact, so that flow is impeded and a stiff jelly is produced. This is what happens when starch puddings are prepared in the kitchen.

The molecular changes taking place during gelatinization are not well understood, but it seems clear that the remarkable expansion of the granule does not occur merely by its thirstily taking in water to produce internal pressure which pushes the walls out. If this were the situation, the chemist would expect heat energy to be liberated during the process, whereas heat is known to be used up. Rather the molecular chains, radially arranged in the granule, appear to be like extended springs which contract sharply when temperature agitation causes them to be released from (*Continued on page 376*)

Science and Society in the Postwar World

Arts, Letters, and Sciences Must Unite to Maintain Freedom

By James B. Conant

IT may seem to some of you like tempting fate to talk not about the total war in which we are now engaged, but rather about the postvictory world.* Indeed, there are many days when I share this mood, for perhaps too many people are now planning rabbit stew before we have caught the rabbit. We must all agree that there is just one immediate goal before us: an unconditional surrender of the Axis powers in the shortest space of time. And before that goal is reached, sorrow, suffering, and misery will be the lot of many in these United States. Yet no sacrifice can be too great which the military may demand, for only by the strength of arms can we shorten the present agony of the world.

It is not my purpose to speak of the war's devastating effect on the colleges and on the universities of the land. For the moment, the creative activities of the scholar in the arts, the letters, and the sciences are at best confined and cramped, in many cases suspended for the duration. Of these war casualties in the academic field I do not propose to speak. But there is one relatively minor disturbance caused by the war, about which I should like to address a word to this joint meeting of Sigma Xi and Phi Beta Kappa. The war now threatens to stir up the smoldering embers of a feud that should have died at least 50 years ago. For generations there have been those on every campus who wished to place the natural sciences and the humanities at antithetical poles. In recent years these old academic quarrels have tended to disappear, yet now we see signs of a renewal of the controversy. I am sure this audience of scholars agrees that the whole idea of a dichotomy between science and the liberal arts is foolish. Everyone admits that the present necessary emphasis on scientific and technical training in preparation for war distorts completely our educational picture. In the postwar world the proper balance must be restored. The challenge which lies before our faculties, therefore, is not to adjudicate an issue as to which of two branches of learning shall stand at the top of the academic hierarchy. Our challenge is to find the ways of combining the study of both man and nature for the maintenance of the ideals of freedom on this continent for the generations yet to come.

From the Blashfield murals in Morss Hall, Walker Memorial, Science is symbolized with its powers for good or ill . . .

In this year when we are celebrating the bicentennial of the birth of Thomas Jefferson, it is perhaps appropriate to take as a text for a discussion of science and society a quotation from his works. Those of you who have enjoyed the recent book, *Jefferson Himself*, will remember the extract from Jefferson's letter to President Willard of Harvard College written on March 24, 1789, from Paris:

"What a field have we at our doors to signalize ourselves in! The botany of America is far from being exhausted, its mineralogy is untouched, and its natural history or zoology totally mistaken and misrepresented. . . . It is the work to which the young men whom you [at Harvard] are forming should lay their hands. We have spent the prime of our lives in procuring them the precious blessing of liberty. Let them spend theirs in showing that it is the great parent of *science* and of virtue; and that a nation will be great in both always in proportion as it is free."

The cause of freedom is at this moment threatened by a force beyond even Jefferson's power of imagination. To combat this evil force, applied science in the hands of free men is a priceless weapon. For the moment, therefore, the engineers and physicists can make through their professions a special and invaluable contribution to the national effort, though, of course, the advancement of science in all but an extremely limited direction must thus all but cease. After the war is over, we as a nation shall also need the services of the applied sciences — not for war but to improve the arts of peace. But in that task if the scientist serves alone, he fails. Technological advances based on the discoveries of science will be as essential in the future as in the past to provide the basis for the continuing growth of our modern civilization. Through many advances gained by science, we may hope that as never before man may be free — free from want. But science alone, untempered by other knowledge, can lead not to freedom but to slavery. This the totalitarian countries have demonstrated beyond doubt or question. Therefore, at the root of the relation between science and society in the postwar world must lie a proper educational concept of the interconnection of our new scientific knowledge and our older humanistic studies. Teachers of the social sciences and the humanities can hardly relate their teaching to the present if they are ignorant of one of the forces which

* This article is drawn from an address delivered by Dr. Conant at a joint meeting of the Harvard chapters of Sigma Xi and Phi Beta Kappa on April 5. — *Ed.*

has reshaped our world. Those skilled in the natural sciences and their application, on the other hand, must be so educated as to understand not only how inanimate materials can be shaped to human usage but how men and women can work together for the maintenance of a nation that is truly free. It is for these reasons that I take it as a good omen that the two companies of scholars, Phi Beta Kappa and Sigma Xi, have met together. I count it a special privilege to be on the platform. I can only hope this new battalion of arts, letters, and the sciences may remain united through war and peace. . . .

It is my thesis that in one respect the future will be like the past. If we are to have a free society on this continent, we must continue to have advances in the fundamental sciences, and these advances in turn can take place only if man is free. It matters little whether we argue for personal liberty so that science and other activities of the creative human mind will prosper, or whether we argue that only through a nourishing of such activities can we have continued freedom in this land. Only let no man who admires science or extols new industrial techniques look with favor on any abridgment of human liberty unless he wishes to encourage forces which will eventually destroy those things he values most. Likewise, let no one primarily concerned with the freedom of individuals attempt to check scientific progress unless he wishes to eliminate a vital part of the chain on which depend his most cherished aspirations.

If I were addressing only engineers and physical scientists, I would urge that as they value the future of their own enthusiasms, they must be concerned with the social and political problems of tomorrow. For unless these problems can be solved, liberty will go. If I were addressing only social scientists concerned with planning the postwar world, I would urge that they provide for a flourishing condition of research and development of new inventions. For I would say that without the products of such research their postwar world cannot meet the conditions of survival. In short, in the postwar world a free society will require technological and scientific progress, and research and development in turn will require a free society. Such is the essence of my argument — of the small segment which I have carved out of my larger title to discuss.

It is not for me to attempt here to suggest the way in which our industrial society must be organized to insure the maximum distribution of the goods we can now so readily manufacture, though unless we have a proper distribution, our freedom will not long endure. Nor is this the place to discuss the difficult problems of arranging for a peaceful international order, though a successful solution of these problems is a prerequisite for the maintenance of our liberty. We cannot maintain a free society in a world in which we must face the terrible and disrupting burdens of modern war once every generation. I am going to confine myself to a discussion of the conditions which I believe must be met if research in the physical sciences and the developments based on research are to prosper in the United States in the postwar world.

In the first place, if scientific work is to prosper we must recognize the prime significance of the exceptional man. Research and development of new scientific ideas are original work — a work in which only a few have the talent to be real leaders. Ten second-rate men are not a substitute for one first-class man. You cannot make up for lack of quality by increasing the quantity of scientific work. It is of the first importance, therefore, to provide a flexible organization for the research work of the nation. Those in each generation who can "turn the unexpected corner" must be given an opportunity to use their special gifts. Andrew Carnegie, in founding the institution which bears his name, stated that one of the two aims of the new research foundation should be: "To discover the exceptional man in every department of study, whenever and wherever found . . . and enable him to make the work for which he seems specially designed his life work." I suggest this statement might stand first in the aims of a country which wishes to encourage science and engineering.

The second proposition which I should inscribe on a charter of a nation's scientific effort would be the necessity for scientific competition. In the days of peace we heard occasional laments about the duplication of scientific effort. That there was in certain areas reason for such lamentation we may perhaps admit. But few who worry on this score realize that unless a number of able teams of scientists are working in each major field, progress is almost certain to be slow. No single scientist is wise enough — not even the exceptional man — to see all the implications in the new facts which are daily uncovered on the frontiers of science. No one group is able enough to explore adequately all the new paths that open. And scientists are human beings subject to the same motivations as the rest of men. The spirit of emulation is strong; the desire to be first in the race is there. If society is to benefit from the zest of the adventure, we must provide a proper environment for research. We must provide that many groups of able men will compete with each other to see who can contribute the most to the advancement of their chosen field.

The third proposition relates to the fact that in almost all fields of the natural sciences the day of the lone worker with scanty equipment has long since passed. In physics, in chemistry, in biology, in medicine, in all the branches of the applied sciences, we must have groups of men well supplied with laboratories and equipment. The sums of money involved are large. In the 1950's they will be larger (*Continued on page 388*)

. . . and Humanity here is represented as being conducted forward from chaos to light by Knowledge and Imagination.

Shall We Ration Crowding?

Dwelling Space Is Packed Not for Congestion's Sake but for Convenience; Standards of Population Density Must Be Established

By Frederick J. Adams

A GREAT deal of publicity has been given in recent months to the urgent need for preparing plans for the rebuilding of our cities in order that blueprints and cost estimates may be made ready against the day when the man-power problem will be that of finding work for our men rather than men for our work. This day will come, perhaps unexpectedly, and there is no doubt that one of the greatest obstacles to the provision of a decent standard of living for many millions of our citizens would be removed if some of the man power available after the war were utilized on an intelligently directed and comprehensive program of urban reconstruction.*

Can scientific methods be applied to the replanning and rebuilding of our cities to the same extent as in the design of highways, bridges, and tunnels, and in the working out of solutions to other problems of municipal engineering? We are forced to admit that we are not on such sure ground when we get to the form, pattern, or arrangement of the future city, because the physical and economic factors are so frequently controlled or limited by social considerations. Qualitative criteria are more elusive than quantitative standards, and both are dependent to a greater or lesser extent on the state of public opinion. What standards will the voting and taxpaying citizens accept? And are they likely to approve of higher standards tomorrow than they do today? At least in one direction the consensus, expert and otherwise, seems to be practically unanimous and that is in regard to the evils attendant on the overcrowding of land, whether by people or buildings, and it is in this direction, among others, that quantitative standards based on objective analyses are needed.

Before we attempt to set up such standards, we must face the fact that there is a fundamental conflict between economic and social considerations which has to be resolved before any progress can be made. Despite the adoption of more or less restrictive zoning ordinances during the last 25 years, the major factor in determining the intensity of land crowding is still the so-called real value of land. A private builder or promoter knows that in order to get a satisfactory return on his investment, he must maintain an easily computed relationship between the total rentable floor space of his building and the cost of the site. In other words, the land value is allowed to dictate the so-called economic height and coverage of a building. In a rising market, such as we had in the 1920's, higher building densities brought about higher land valuations, so that a vicious circle was started which, despite the depression, has not yet been broken. We now find ourselves in a position where substantial portions of our urban blighted districts are being held by the owners, and taxed by the municipalities, at prices which have no relation to the ability of the land to produce revenue. To recognize these inflated values as an appropriate basis for computing reasonable population densities to be applied to the future development of our urban areas would be like trying to rectify an error by canceling it with another.

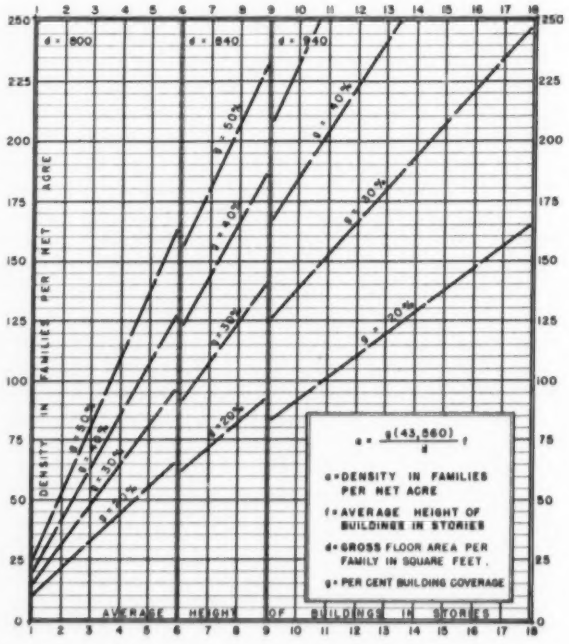
The alternative open to us seems to be either to continue allowing population densities in urban residential areas to be determined by the laws of the market place, or else to adopt criteria based on the minimum requirements of everyday living. People do not live in crowded

DENSITY STANDARDS FOR MULTI-FAMILY RESIDENTIAL AREAS

CHART I

DENSITIES PER NET ACRE

IN RELATION TO HEIGHT AND COVERAGE OF BUILDINGS


d = 800
d = 840
d = 940
g = 50%
g = 40%
g = 30%
g = 20%
DENSITY IN FAMILIES PER NET ACRE
AVERAGE HEIGHT OF BUILDINGS IN STORIES
d = DENSITY IN FAMILIES PER NET ACRE
f = AVERAGE HEIGHT OF BUILDINGS IN STORIES
d = GROSS FLOOR AREA PER FAMILY IN SQUARE FEET.
g = PER CENT BUILDING COVERAGE

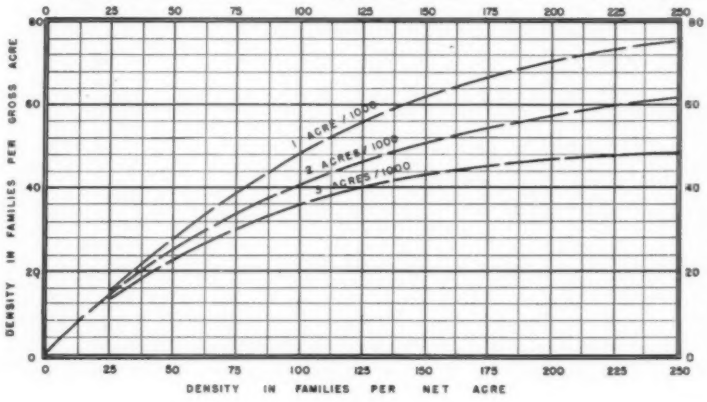
* The statistical material presented in this article was prepared by the author for consideration by the American Public Health Association's committee on the hygiene of housing and particularly by its subcommittee on environmental standards for residential areas, of which the author is chairman.

DENSITY STANDARDS FOR MULTI-FAMILY RESIDENTIAL AREAS

CHART II

GROSS DENSITY IN RELATION TO NET DENSITY

VARYING WITH ADOPTED STANDARD OF PUBLIC RECREATIONAL AREA PER 1000 PERSONS



neighborhoods because of the congestion but because of the convenience of location. It is not even reasonable to assume that the prevalence of apartment houses in our large cities is because most urban families prefer that manner of living. More likely assumptions are that this form of structure was elected by the developer as the most profitable type of residential building (i.e., the type which can carry the highest amount of land cost) and that the choice of many families who wish to locate in a specific section of a city is between one multifamily building and another rather than between an apartment and some other type of dwelling.

The very fact that our blighted urban residential districts are frequently overpopulated and overpriced means that without some form of subsidy they cannot be cleared away and rebuilt with new structures, however high the density, to house the same economic group that now resides in these areas. Annual charges on construction costs alone would normally absorb more than the income from a low-rent project which has to pay the usual financing charges, taxes, and operating costs. If we are going to make any attempt to rehouse a substantial proportion of families now living in substandard conditions, we may as well face at the start the fact that we cannot put the program on a self-liquidating basis — and if we then realize that it is primarily the high land cost which has to be subsidized (whether by a governmental or a philanthropic agency), we have little excuse for adopting density standards which would make possible the development of anything other than a desirable neighborhood pattern.

What is a "desirable neighborhood pattern" and can it be put into quantitative terms which will stand close inspection? To answer these questions is not an easy job, and yet for want of a serious attempt at an answer city planners have been criticized as opposing the overcrowding of land without being willing to state specifically what they mean by "overcrowding." * Before a suitable over-all density standard can be determined, the spatial requirements of a neighborhood must be classified by function and size. It is not difficult to segregate three primary elements which combine to form the neighborhood environment for family living and for which minimum areas per room or per family must be established, namely, (1) buildable land — defined for our present purpose as "net area"; (2) streets; and (3) land set aside for recreational use. The charts on these pages and the tables grouped on page 370 are based on the family as the unit for which appropriate space allocations are made; estimates of density in terms of families-per-gross-acre are predicated on the assumption that the average dwelling unit in an urban residential area would have at least four rooms and that the average family size would be 3.5 persons.

Minimum street space per family, to provide both for moving traffic and for parked vehicles, has been determined on the basis of sample studies made in residential neighborhoods of different sizes, with buildings of varying height and coverage. A further assumption is that up to 50 per cent of the private land not covered by buildings might be available for automobile parking but that only 20 per cent of the total street area could reasonably be set aside for this purpose. An allowance has been made on a per-family basis for neighborhood shopping facilities, although the area required is small and such facilities in central portions of cities might often be accommodated in the first floor of residential buildings.

Among the standards adopted for this study, probably the most controversial is that relating to parks, playgrounds, and other public open spaces. An allowance of

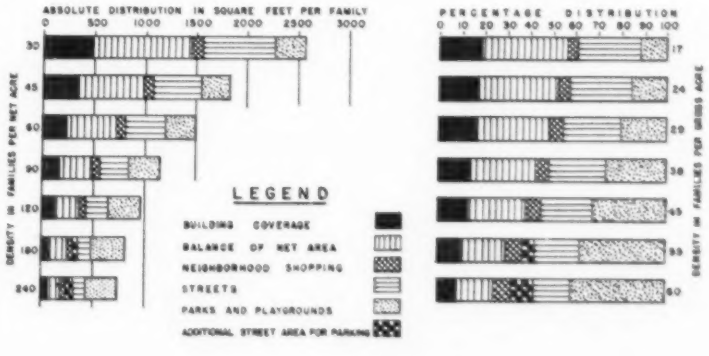
* Presumably the English standard for low-rent housing — 12 units to the acre, including the area in streets as well as in house lots — would not be acceptable if applied to the central portions of our large American cities, although we have been told recently by Sir Ernest Simon that British authorities intend to hold to the 12-unit figure as the maximum density to be permitted in any circumstances in Great Britain's postwar housing program.

DENSITY STANDARDS FOR MULTI-FAMILY RESIDENTIAL AREAS

CHART III

REPRESENTATION OF TABLES III AND IV

SPATIAL REQUIREMENTS PER FAMILY



two acres per 1,000 persons may be considered by some too generous a recreational standard for application to existing urban areas with a high percentage of building density and a high unit land cost. However, there is more evidence to show that the standard is too low for general adoption than that it is not low enough, provided — and this fact is important — the hypothesis is accepted that residential areas with a high density per net acre should have at least as much public open space per capita as do similar areas of low density.

It is the writer's belief not only that this hypothesis is sound but that the public area per capita should be *increased* in proportion to any addition in net density, for under typical conditions an increase in the latter is always accompanied by a decrease in the per-capita amount of usable private land (that part of the net area not covered by buildings). For example, if a maximum of 35 per cent of the total net area is assumed to be usable for recreation, the area per family for such a purpose would decrease from about 500 square feet at a density of 30 families per acre to 65 square feet at a density of 240 families per acre (see Table 3). The actual result is to provide the less densely settled district with more acres of private land per 1,000 persons than are available to the more thickly populated district. The gross amount of private and public land for all types of recreation for the two areas would therefore be 5.5 acres and 2.5 acres per 1,000 persons, respectively.

On the basis of the foregoing figures, one would have good reason for maintaining that the minimum standard of public open area should range from 1.5 acres per 1,000 at net densities of 30 families per acre or less, up to 2.5 acres per 1,000 at net densities of 240 families per acre or more. This would result in a minimum over-all standard of about three acres of combined public and private recreational space per 1,000 persons for the whole range of densities. This figure, of course, would apply primarily to districts where the population characteristics are typical; the ratio of recreational area per capita would have to be adjusted for variations from the normal in percentage of child population and for the occupational and ethnic groups residing in a given district. In view of the fact that changes are likely to take place in population composition over a period of years, however, adoption of a minimum standard based on normal conditions would be much safer.

The tables and charts accompanying this article have been purposely designed so that they do not in themselves give minimum standards of density but permit such standards to be derived easily, once certain basic factors have been established or agreed upon. For instance, if for various reasons — social and economic — elevator apartment buildings were agreed to be unsuitable for families in the lower income groups, then the estimate of maximum density would be based on a maximum height of three or four stories. With a maximum building coverage of 30 (*Continued on page 384*)

TABLE 1

Densities Per Net Acre in Relation to Height and Coverage of Buildings

(*a*) Density in families per net acre	30	45	60	90	120	180	240
(*b*) Density in persons per net acre at 3.5 persons per family	105	158	210	315	420	630	840
(*c*) Net area of lot per family in square feet	1,450	970	725	485	360	240	180
(*d*) Gross floor area per family in square feet	800	800	800	840	940	940	940
(*e*) Ratio of average gross floor area to net area of lot; $\frac{(d)}{(c)}$	0.55	0.82	1.10	1.73	2.60	3.90	5.22
(*f*) Average height of buildings in stories, assuming average building coverage of approximately 30 per cent; $\frac{100(e)}{30}$	2	3	4	6	9	13	17

TABLE 2

Minimum Street and Parking Area per Room in Relation to Density per Net Acre

(*a*) Density in families per net acre	30	45	60	90	120	180	240
(*b*) Average building coverage	30%	30%	30%	30%	30%	30%	30%
(*c*) Net area per family in square feet (From Table 1)	1,450	970	725	485	360	240	180
(*d*) Area of lot not covered by buildings; 70 per cent of (*c*)	1,015	680	508	340	252	168	126
(*e*) Average street area per family	700	480	380	280	220	150	120
(*f*) Available parking space per family; 50 per cent of (*d*) plus 20 per cent of (*e*)	648	436	330	226	170	114	87
(*g*) Area to be added to street area (*e*) in order to bring minimum parking space per family up to 160 square feet	0	0	0	0	0	46	73
(*h*) Total street area per family in square feet; (*e*) plus (*g*)	700	480	380	280	220	196	193

TABLE 3

Maximum Density per Gross Acre Obtainable at Various Densities per Net Acre

(*a*) Density in families per net acre	30	45	60	90	120	180	240
(*b*) Net area per family in square feet; item (*c*), Table 2. Additional allowance for local shopping facilities	1,450	970	725	485	360	240	180
	105	90	90	70	70	60	55
(*c*) Total net area	1,555	1,060	815	555	430	300	235
(*d*) Area of parks and playgrounds per family at 2 acres per 1,000 persons	305	305	305	305	305	305	305
(*e*) Total street area per family; item (*h*), Table 2	700	480	380	280	220	196	193
(*f*) Gross area per family in square feet; (*c*) plus (*d*) plus (*e*)	2,560	1,845	1,500	1,140	955	801	733
(*g*) Density in families per gross acre (approximate)	17	24	29	38	45	55	60

TABLE 4

Proportionate Land Uses at Various Densities per Gross Acre
(Derived from Table 3)

Density in families per gross acre		17	24	29	38	45	55	60
Per cent of gross area in:								
Net area	Residential	57.0	52.5	48.5	42.5	37.5	30.0	24.5
	Commercial	4.0	5.0	6.0	6.0	7.5	7.5	7.5
Parks		12.0	16.5	20.5	27.0	32.0	38.0	41.5
Streets		27.0	26.0	25.0	24.5	23.0	24.5	26.5

Research and Patents

Serious Detriment to Industry and to Society Would Result from Drastic Alteration of the American Patent System

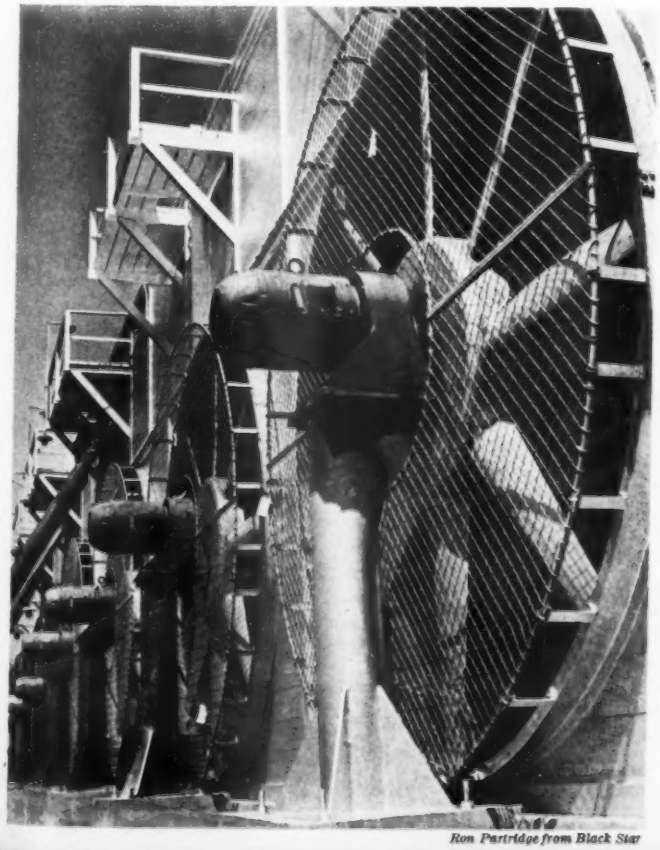
By Robert E. Wilson

PART II

CRITICS of the American patent system who urge drastic changes in it level their heaviest attack, as we have seen, on the licensing aspect of the system. Much argument holds that licensing should be made compulsory; much demands that restrictions on licenses be prohibited. In The Review for April, I discussed these contentions, both of which appear highly undesirable, the first largely because it cancels the very reward the inventor was supposed to receive — that of a limited monopoly upon his invention in return for his disclosure of it; the second because the net effect of forbidding restrictions in licenses is, from a practical point of view, quite likely to be the opposite of that intended.

Yet to condemn these drastic suggestions, as I think they should be condemned, does not mean that other ways of improvement do not exist. One abuse which has been clearly evident in a few patent cases in recent years is the practice of deliberately and excessively prolonging the period of argument back and forth in the Patent Office so that a patent is not issued until many years after the application, in order to get the benefit of a later effective period of life. For this reason, one of the suggested reforms which seems to me to have real merit would keep the life of the patent at not more than 17 years but also limit the expiration date to be not more than 20 years after the application was filed. Even the 17-year life is open to question in view of the accelerated industrial tempo which, in general, makes it possible to get a new invention into operation much more promptly than when the 17-year term was originally set. On the other hand, to make and develop new inventions is getting more expensive and difficult as the frontiers of science are pushed farther afield; hence some offsetting increase in incentive is desirable. Seventeen years seem like a long period when we are in the midst of a new development, but they represent a short time in the life of a nation or an industry. Certainly no one today begrudges Bell his monopoly on the telephone from 1876 to 1893.

Cooling tower at a sodium plant



Ron Partridge from Black Star

It must be conceded that a large number of patents issued by our Patent Office relate to petty details of routine improvement and do not cover true inventions. Despite the fact that these weak patents are being consistently knocked down by the courts, they are often a source of harassment, confusion, and expense. The Patent Office seems to me to have too low a standard of patent-ability and the courts in recent times too awesomely high a standard. Although the Patent Office is required to resolve its doubts in favor of the inventor, it seems in general to have been too liberal. The Patent Office is not alone at fault here, for it is subjected by attorneys and applicants to strong and relentless pressure to issue some kind of a patent even though the applicant or attorney realizes that the patent may be of doubtful validity. This type of patent is sometimes called an "insurance patent" because its main purpose is to prevent someone else from being granted a patent on the same thing later.

The character of patents probably would also be improved simply by a rise in the salary standards in the Patent Office. The present salary situation is such that the patent examiner has little incentive to regard service in the Patent Office as a lifetime career, with the result that that office functions to a considerable degree as a training school for patent attorneys. Improvement is likewise desirable in the information available to examiners in making searches for patentable novelty. Much practical knowledge and information from the industry should be, but is not, available in the Patent Office. One constructive move to help remedy this situation would be to establish a procedure whereby the examiners, at least those of senior rank, would have frequent personal contact with development and manufacturing in the fields which they are examining.

For an authoritative and considered statement of the relation between patents and research, one would logically go to the National Research Council. In their December, 1940, report to the National Resources Planning Board, they have said: "It is generally recognized . . . that patents play an important part in the motivation of research, and no changes in the patent system should be made without most careful consideration of possible effects on the welfare of industrial research."

Emasculation of our patent system is bound to discourage much industrial research, which has grown so amazingly in recent years that it employed about 70,000 research workers in 1940. The effect on the amount of research done in any particular instance, however, will vary greatly with the industry and especially with the size of the company. The long-run effect of emasculation would seem to be in a direction that is socially undesirable, as the competitive position of the smaller companies will be weakened. Let us consider the relative effect on companies of various sizes.

A drastic weakening of our patent system will least affect the research policies of the large companies. In all their principal fields of activity they can readily afford to carry on research programs, solely for the purpose of maintaining their competitive position and keeping down their manufacturing costs. They regard royalties mainly as incidental by-products of their research, and their chief interest in patents is to help them secure maximum operating freedom by virtue of exchanges of licenses. Obviously, if such companies find it expedient not to depend on patents, they will not stop their research but will tend to keep their know-how largely to themselves.

The effect of emasculation of our patent system on the research activities of medium-sized and small companies will be much more severe. They must have some research organization if they are to keep anywhere near abreast of competition, but their laboratories cannot possibly do original research in all their fields of activity. They concentrate in general on their operating problems and the application of various patented processes to their own needs. In either type of work, they frequently run across some new ideas which seem to have merit; as long as they have the prospect of patent protection and substantial royalty income, they can and do exploit such ideas, at least through the phase of laboratory development, even though their own activities would not justify the cost of a thorough investigation. Many small laboratories have more than financed all their research activities by one or two important inventions. Also, when such companies reach the point of needing to undertake large-scale development — which in our industry frequently costs several hundred thousand or even a few million dollars — they can, by virtue of patent protection, usually interest other companies in joining with them and sharing the development costs. Several small companies in our industry have attained a position of pre-eminence in certain fields by just such methods. Without the incentive and protection of a sound patent system, however, the ideas would probably never have been developed. As Conway P. Coe, commissioner of patents, has said: "Speculative capital will not back new inventions without patent protection."

Moreover, without our patent and licensing system, the companies which develop major new processes would not be giving out information and trying to sell licenses. Hence the smaller companies would not be able to study promptly the application of new processes to their own needs, so that the whole process of development in industry would be retarded.

In addition to the research conducted by operating companies, many industries have one or more nonoperating companies which maintain programs of research and development that have resulted in important processes. Outstanding among these in the petroleum industry is the Universal Oil Products Company, which developed the Dubbs cracking process. For over 20 years this company has maintained a large research staff and has made many outstanding contributions to the refining of petroleum and to the chemical field as well. It has spent approximately $25,000,000 for research and process development, more recently at the rate of about $2,000,000 annually. The income of the company is derived entirely from the licensing of its patented processes, and the major portion of its royalty income has been used for the continuing of research and development. The income derived from royalties on thermal cracking was largely used to study and develop some of the present catalytic processes so vital in the war effort, including catalytic cracking, alkylation, isomerization and dehydrogenation for aviation gasoline, and other processes for the production of components of synthetic rubber, and so on. Universal Oil Products also maintains a group of skilled technicians who for years have advised and assisted its smaller refiner licensees to maintain their operations on the most efficient basis. The weakening of our patent system would automatically result in the disappearance of these research, development, and licensing companies, which have proved particularly important to the smaller operating companies.

A generation ago most research workers in the medical field and many of those working in our universities felt that the patenting of their discoveries was not quite ethical, especially in fields relating to public health. During the past 20 years, however, recognition of three facts has been growing: (1) Failure to patent is more likely to delay than to encourage the development and marketing of new products, particularly if any substantial investment or advertising is required to get them started. (2) Failure to patent leaves new remedies open to widespread abuse by unethical manufacturers and promoters, whereas patenting permits a control of quality and marketing practices which is highly desirable with many of the new drugs. (3) Failure to patent simply takes away a large potential income from those who benefit from new discoveries — income which might better be collected and used to promote further research in related fields. Growing appreciation of these three facts has largely changed the attitude of the workers in these fields, so that patenting is now the usual practice. Partly because of the outstanding example of the Wisconsin Alumni Research Foundation, millions of dollars a year in royalties obtained from the inventions of earlier workers are today being devoted to pure research in medical and other lines, generally in the same organizations. This sound and socially (*Continued on page 394*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Killian Named Executive Vice-president

The Review's Former Editor, Executive Assistant to President Compton Since 1939, Assumes New Office on July 1

© Bachrach

James R. Killian, Jr., '26

THE appointment of James R. Killian, Jr., '26, as executive vice-president of the Institute was announced by President Compton on April 16. Mr. Killian has been executive assistant to Dr. Compton since January, 1939, and his new appointment becomes effective on July 1.

In making the announcement, President Compton said: "The war has multiplied by several times the amount of the Institute's activities and has also complicated all operating details. Mr. Killian has shown fine executive capacity in dealing with such matters. He furthermore knows intimately our internal affairs and our alumni organization, and has the confidence of all his associates to an extraordinary degree. As executive vice-president, Mr. Killian will continue to work for the prompt and efficient execution of the business coming to the President's Office and will handle certain coordinating responsibilities."

Before joining the staff of the President in 1939, Mr. Killian had been associated for 13 years with the publication of The Review, of which he became editor in 1930. He is widely known among the Alumni, is a former treasurer of the Alumni Association, and is chairman of the Advisory Council on Undergraduate Publications. His administrative duties include the chairmanship of the Board of Publications of the Technology Press.

Mr. Killian is a member of the American Association for the Advancement of Science and the Society for the Promotion of Engineering Education. He is a member of the St. Botolph Club of Boston, and his fraternity is Sigma Chi. He was born in Blacksburg, S. C., in 1904, the son of James R. and Jeannette Rhyne Killian. He studied for several years at Duke University before coming to Technology, where he was awarded the degree of bachelor of science.

Faculty Changes

PROMOTIONS on the Faculty of the Institute for the next academic year, effective July 1, include three advancements to the rank of professor: Douglass V. Brown, Department of Economics and Social Science; Frederick H. Norton, '18, Department of Metallurgy; and John B. Wilbur, '26, Department of Civil and Sanitary Engineering.

Promoted to the rank of associate professor are Robert H. Cameron, Department of Mathematics; Harold W. Fairbairn and Robert R. Shrock, Department of Geology; Ernest N. Gelotte, '23, School of Architecture; Bernard S. Gould, '32, Department of Biology and Biological Engineering; George G. Harvey, Department of Physics; Walter McKay, '34, and Manfred Rauscher, '26, Department of Aeronautical Engineering; and Herman P. Meissner, '29, Department of Chemical Engineering.

Members of the staff advanced to the grade of assistant professor are Douglas P. Adams, Section of Graphics; Joseph Bicknell, '34, Department of Aeronautical Engineering; Paul M. Chalmers and John B. Rae, Department of English and History; Kenneth R. Fox, '40, Department of Mechanical Engineering; Thomas R. P. Gibb, Jr., '40, and Walter H. Stockmayer, '35, Department of Chemistry; Albert C. Hall, '37, Department of Electrical Engineering; Irving Knickerbocker, '24, Department of Economics and Social Science; Thomas F. Malone, Department of Meteorology; and P. Charles Stein, '40, Department of Civil and Sanitary Engineering.

Promotions to the grade of instructor include those of Donald P. Campbell, Roberto M. Fano, '41, Robert C. Habich, Walter K. Halstead, '39, William L. Root, and James N. Thurston, all of the Department of Elec-

trical Engineering; Pei-Moo Ku, '42, Department of Aeronautical Engineering; and Charles F. Peck, Jr., '41, Department of Civil and Sanitary Engineering.

Members of the Faculty who will retire on July 1 are Professor Harry W. Gardner, '94, of the School of Architecture; Professor George E. Russell, '00, of the Department of Civil and Sanitary Engineering, who has been appointed a lecturer for the next academic year; and Professor Miles S. Sherrill, '99, of the Department of Chemistry.

Professor Gardner joined the staff of the Institute in 1895, the year after his graduation. He has served without interruption since his original appointment. Professor Russell joined the staff immediately after receiving his degree in 1900. Widely known in engineering circles, he has held many public appointments and served on various engineering commissions. Professor Sherrill became a member of the staff in the year of his graduation and has been one of the Institute's distinguished teachers in the field of chemistry.

The Council Meets

MEETING at the University Club in Boston, since Walker is not available at present because of wartime necessities, the Alumni Council held its 231st session on the last Monday in March, under the chairmanship of Vice-president Harold Bugbee, '20, who acted in the absence of President Francis A. Barrett, '24. The meeting was well attended.

Aspects of the way in which the war has affected programs at the Institute, with particular emphasis on undergraduate affairs, were presented by the three speakers: John D. Mitsch, '20, Associate Professor of Structural Engineering, who is armed services representative at Technology; Joseph C. MacKinnon, '13, registrar; and James R. Killian, Jr., '26, executive assistant to President Compton. Professor Mitsch reviewed the frequently changing situation of enlistments and deferments of undergraduate students, bringing the story down to the present time and outlining the details of the Navy V-12 plan and the Army Specialized Training Program as they are now constituted. Mr. MacKinnon discussed enrollment at the Institute, showing by means of detailed figures the gradual change from a student body consisting largely of civilians to one in which Army and Navy students will be the larger group.

Mr. Killian related some of the financial and administrative problems involved in the meeting of these wartime requirements. Describing the man-power situation, particularly as it has to do with men of college age, he outlined the effect of the Army and Navy programs in markedly reducing the number of civilian students available to the many colleges in the country. He sketched the contractual basis on which the Institute will conduct scientific and engineering courses for the Army and Navy and will continue its research for government and industry, and described various individual problems encountered as a result of the necessity for rearrangement of space, reassignment of staff, and accommodations for housing and feeding the larger Institute population.

Business of the meeting, in addition to routine reports, included recommendation by the nominating committee on advisory councils, presented by A. Warren Norton, '21, that the present membership of the advisory groups be continued in office for indefinite terms in order that unpredictable needs may be best met. Re-establishment of the definite terms of office will be brought up for consideration after the wartime dislocations have terminated, according to the recommendation of the committee, which was passed.

Resolutions in memory of Charles T. Main, '76, were presented by Walter Humphreys, '97, chairman of a committee including Henry E. Worcester, '97, and William M. Bassett, '02. C. Yardley Chittick, '22, chairman, spoke for a committee comprising Winthrop Cole, '87, and Richard Whiting, '26, in presenting resolutions in memory of Giles Taintor, '87. A silent rising tribute adopted the resolutions of each committee.

Visiting Committee Report

THE Committee on the Department of Business and Engineering Administration* met on December 11. Robert G. Caldwell, Dean of Humanities; Professor Erwin H. Schell, '12, Head of the Department; and James R. Killian, Jr., '26, executive assistant to President Compton, also were present. Members of the staff of the Department and three representative students attended portions of the meeting.

Professor Schell reported on activities of the Department and on action taken since the meeting of the Committee in April, 1942. Analyses presented showed that, with 177 students as of November 2, the Department shared with the Department of Naval Architecture and Marine Engineering the fourth place in the number of students enrolled in the various Departments of the Institute. Many of the special courses in the Department's curriculum are given by the Department of Economics and Social Science, and the engineering subjects are within other Courses. The total of 11 professors and instructors, therefore, is one of the smallest of any of the Departments.

In so far as present uncertainties permit, provision is being made for adjustment to enrollment and other changes necessitated by the emergency. The smallness of the Faculty group reduces the severity of the adjustment, and the Department believes that the plans are adequate for the immediate future at least.

The *Handbook of War Production*, written by Edwin A. Boyan, '36, formerly of the Department, and published by McGraw-Hill, was reported a success, with a second printing already authorized. Another book is planned, to be based on studies now being made. Several theses directed by William Van Alan Clark, Jr., '42, formerly a research assistant in the Department, covered various aspects of serialized production. These studies disclosed problems which will provide a foundation for constructive publications in the Department's series of books. A series of such publications is considered

* Members of the Committee for 1942–1943 are Edward P. Brooks, '17, Chairman, Frank W. Lovejoy, '94, Raymond Stevens, '17, Frederick S. Blackall, Jr., '22, Carl T. Keller, Edward R. Stettinius, Jr., and Roy A. Young.

by Professor Schell a significant part of the over-all activity of the Department.

A chart of placement tabulation was presented at the meeting. This showed a steady increase in the percentage of the Department's graduates now in the Army and Navy — from the first Class of 1917 to the Class of 1942, of whom 70 per cent are in some sort of war service.

Interest was shown in a request from the Puerto Rico Development Company for the training of a group of Puerto Rican engineering graduates for a place in the operation of new industries contemplated for that territory. The plan presented for the company's consideration provides for a procedure much like that previously established by the Department for the Sloan fellowship groups. [This plan has subsequently been accepted.]

Special consideration is now being given by the Department to the subject of new-product control. This is leading to a postwar course, and preliminary steps have already been initiated. Working with Professor Schell on the formulation of a special course or group of courses in this subject are Ross M. Cunningham, Assistant Professor of Marketing; Ronald H. Robnett, Associate Professor of Accounting; and Gerald B. Tallman, Assistant Professor of Marketing. Studies are being made of the plans and practices in industry for provisions for this management function.

The Committee were impressed with the character and range of material contained in the theses of the Department's undergraduate students, particularly by several major studies which have been made in comparatively recent years. The Committee believe that serious consideration should be given to the possibility of publishing material drawn from these theses as an addition to previous publication practice.

Appointed

THEODORE B. PARKER, '11, chief engineer of the Tennessee Valley Authority, will become head of the Department of Civil and Sanitary Engineering on July 1, President Compton announced last month. Mr. Parker will succeed Professor Charles B. Breed, '97, Head of the Department since 1934, who asked to be relieved of his administrative duties to devote full time to his continuing post as professor of civil engineering.

Mr. Parker's distinguished engineering career with the Tennessee Valley Authority began in 1935, when he was appointed chief construction engineer. Under his direction the huge Norris and Wheeler dams were completed, and he had charge of the design and construction of all subsequent dams up to the present time. This great engineering undertaking includes six additional dams on the Tennessee River and eight major developments on tributary streams. His appointment as chief engineer was made in 1938.

Immediately following his graduation from the Institute in 1911, Mr. Parker was an assistant in the Department of Civil Engineering for one year, leaving to join the staff of H. C. Keith, consulting engineer of New York, with whom he served as a draftsman and computer on highway bridge design. From 1912 to 1917 he was assistant hydraulic engineer of the Utah Power and Light Company at Salt Lake City, and from December, 1917, to March, 1919, he served in the World War as first lieutenant and later captain, commanding Company D of the 26th Engineers in service overseas. Upon his return to civilian life, Mr. Parker joined the engineering staff of the Electric Bond and Share Company of New York, with which he held the post of assistant hydraulic engineer. He served from September, 1920, to November, 1922, with the United States Army as captain in the Corps of Engineers, the period including one year of duty with troops and a year at the Army Engineer School, from which he was graduated in 1922.

Theodore B. Parker, '11

Mr. Parker held the position of hydraulic engineer with the Stone and Webster Engineering Corporation of Boston from 1922 to 1933, designing various hydroelectric developments, including Bartletts Ferry near Columbus, Ga., and the Rock Island development on the Columbia River in Washington. For four months beginning in March, 1933, he attended the United States Army Command and General Staff School at Fort Leavenworth, where he was commissioned a lieutenant colonel in the Corps of Engineers Reserve, a post from which he later resigned. From August, 1933, to November, 1935, he was on the engineering staff of the Federal Emergency Administration of Public Works, serving successively as engineer examiner, state engineer, and acting state director for Massachusetts.

A native of Roxbury, Mass., Mr. Parker is the son of Franklin Wells and Sarah Bissell Parker. In 1913 he married Miss Estelle Peabody of Wellesley. Their son, Franklin P. Parker, was graduated from Technology in 1936 and is now a captain in the Corps of Engineers of the United States Army. Their daughter, Nancy, is a student at Wellesley College.

Mr. Parker is a member of the American Society of Civil Engineers and a director of the Society of American Military Engineers.

CINDERELLA STARCH

(*Continued from page 365*)

some of their attachments to neighbors, as is illustrated in Fig. 3. The result is a striking decrease in chain length, accompanied by considerable thickening. When many chains behave thus in concert, their radial orientation in the granule results in an increase in the area of each concentric layer of the granule. Since the close packing of chains does not allow the radius of the granule to shrink at the same time, the chains pull away from the center to form a cavity.

Actual formation of little evacuated spaces in the center can be demonstrated under appropriate conditions, but in most instances water filters in fast enough through the expanding layers to fill up the vacuum which "Nature abhors" so much. As the water passes through the expanding layers, it dissolves the soluble fractions of the starch, so that when all expansion has ceased a thin wall remains, made of whatever granule material has been undispersed by the water. This wall encloses a body of starch solution, and solution plus resistant wall forms the balloonlike granule of the starch jelly.

At this point it becomes clear for the first time in the present discussion that our Cinderella is not one individual but in reality twins. The existence of two kinds of starch has long been suspected, but recent experiments have succeeded in clarifying the situation considerably. One fraction of the starch, identified by the chemists as "amylose," is that which dissolves in the water during gelatinization, occupying the central cavity and then slowly being lost through the pores of the sack wall into the external solution. The other component is called "amylopectin" and comprises much of the material remaining as the sack wall.

Since they are similar substances, the chemist experiences trouble in thoroughly purifying one starch component of its slightly different companion. The difficultly dispersed molecules may be dragged into solution by several of their soluble relatives, or a soluble one may be trapped in a tangle of resistant molecules. With starch, the problems of separation are even greater than with many other substances, for under proper conditions both amylose and amylopectin are dispersible. Actually, when once "dissolved," amylopectin is more stable in solution than is amylose, and *very pure* amylose often resists solution more than does amylopectin. In the past, this situation has caused much confusion among chemists.

Because of such difficulties, the importance of three different fairly successful methods recently developed for the separation of amylose and amylopectin should not be overlooked. One method simply leaches the amylose solution gently from suspensions of gelatinized granules. Another takes advantage of the observation that ordinary cotton batting placed in a starch solution will, by absorption, preferentially remove the amylose molecules, leaving behind the amylopectin ones. A third investigator has found that when certain higher alcohols, primarily butyl alcohol, are added to starch suspensions, they cause a preponderant precipitation of the amylose.

With the availability of reasonably pure starch fractions has come better characterization of them. The amylose molecule seems most like cellulose in being a linear array of dextrose units; amylopectin has a branched structure, with a treelike ramification of constituent straight-chain segments (Fig. 4). Amylose molecules, which have molecular weights of 13,000 to 60,000, are relatively the smaller, consisting of about 80 to 350 dextrose units arranged to form the single straight chain. Amylopectin molecules may have molecular weights of about 50,000 to 1,000,000, so that 300 to 6,000 dextrose elements compose the molecule, with average straight branches of about 30 dextrose units each. Granules from different sources possess varying proportions of the two components, but commonly about three-fourths of the starch is amylopectin.

With this explanation of the two types of starch molecule, some of the major difficulties in the understanding of this carbohydrate become cleared up. The amylopectin molecule differs chemically from amylose chiefly in the possession of about 3 per cent of the dextrose elements at which branching occurs. Chemically it is difficult to pick out this small proportion and distinguish it from the similar one which constitutes the straight chains, yet the branches result in profound alterations in molecular properties. Some of the differences between the starch twins will become apparent in what follows.

IN the description of the "self-inflation" of starch balloons, the phenomenon was ascribed to certain contractile tendencies of starch molecular chains. While definite knowledge of the precise contracted form is lacking at present and must be left for the future to decide, nevertheless one is tempted to follow the lead of certain investigators in describing "molecular springs" of helical configuration.

Perhaps the best reasons for thinking in terms of helices come from considerations involving certain dextrins, smaller molecules split off from starch by the action of an enzyme obtained from the *Bacillus macerans*. These Schardinger dextrins, named after their discoverer, have been shown by standard chemical methods to be ring-shaped molecules in which dextrose units follow each other, bridged by oxygen atoms as in starch but differing from starch in that the "head" of each chain catches hold of its corresponding "tail" to form a closed cycle (Fig. 5*a*). Early estimates placed upwards of five units per cycle in molecules of the several dextrins of this type found.

One of the most interesting of the Schardinger dextrins — originally called the "α form" but recently, upon x-ray proof that its molecule contains six glucose residues, renamed the "cyclo-hexa-amylose" — crystallizes as beautiful hexagonal plates. More interestingly, it also forms hexagonal blue prisms when iodine is present. The blue iodine color of these prisms is similar to that known far and wide by chemists as typical of the starch-iodine absorption complex, used by investigators as a sensitive color test for starch or for iodine. Ordinary linear dextrin molecules of the same size, in which heads have *not* been joined to tails, do not show iodine coloration.

(*Continued on page 380*)

Ships, too, are here to stay

NEVER before has so great a flood of materials poured from the doors of industry and into the holds of ships. The end of the war, far from cutting off this flood, will merely change its nature from munitions to merchandise.

Shipping will be as vital in winning the peace as it is in winning the war. But old cargo carriers will not long be adequate to maintain the pace of tomorrow's global trade. Into their midst are sure to come new speedsters for ocean express—light-footed craft with structural parts of strong, corrosion-resistant alloys.

Exactly what they will look like, only naval architects might now dare to predict. But it is certain that, in addition to the standard marine metals, a host of new materials will present claims for a part in the construction of these ships. Where and how can each serve the shipbuilder best? Which will be most economical, efficient, enduring, for what purpose?

Revere can supply impartial answers to many of the questions about metals that beset industry. For just as industry in the future will not be restricted to the traditional materials, neither will Revere. Since the start of the war, Revere has not only broadened still further the uses for copper and its alloys, but has developed facilities for manufacture of the light metals, and is pioneering in the production of entirely new alloys that can cut manufacturing costs for many industries.

Today the copper industry is working all-out for victory. No copper is available for anything else. But post-war planners with specific problems in metals are referred directly to the Revere Executive Offices in New York.

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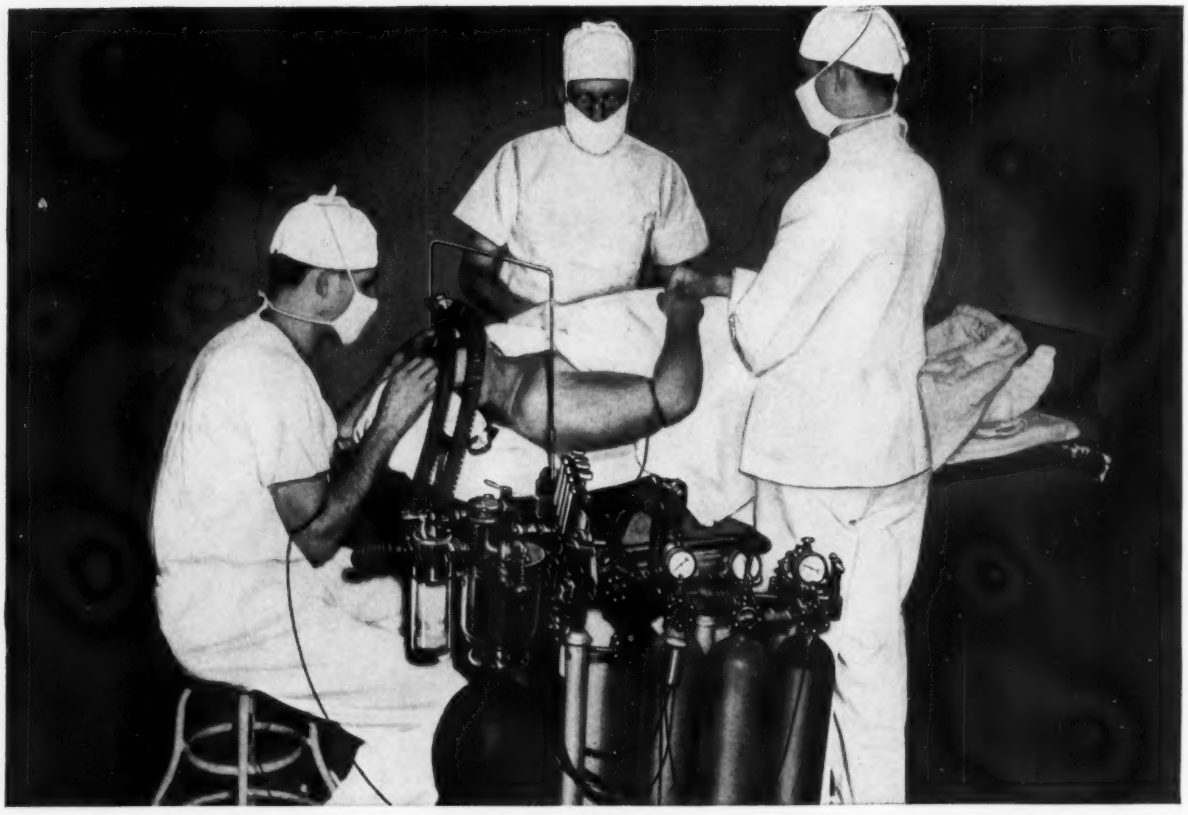

CHAINED... FOR SAFETY

From the time of their earliest use in hospital operating rooms, the handling of most inhalation agents has been fraught with danger of fire or explosion from static sparks. However, this risk did not receive serious recognition until recent years when accepted engineering principles were applied to this aspect of anesthesia and surgery.

With the introduction of cyclopropane and other newer types of gases, further attention was focused on the elimination of this hazard. How could the electrical potentials of the anesthetists, the patient and the apparatus be equalized to eliminate the possibility of spark?

The answer was found in fastening the group together by means of silver chains and other conductive materials. Connected into the circuit, a device consisting of high resistances prevents the formation of a static charge of any important degree of intensity.

IRC is proud to have been consulted and to have lent the aid of its research laboratories to this important scientific development.

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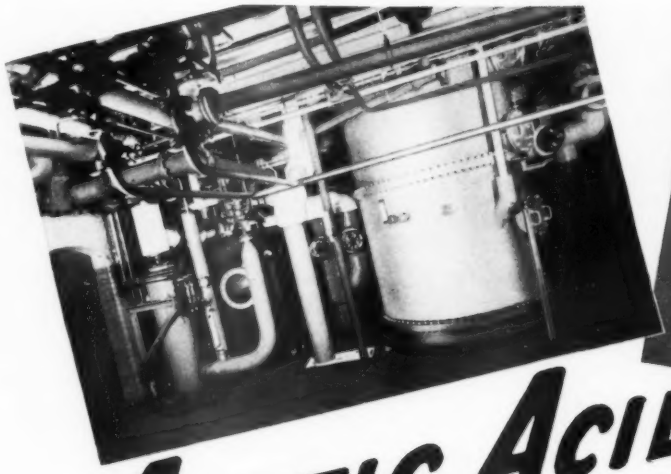
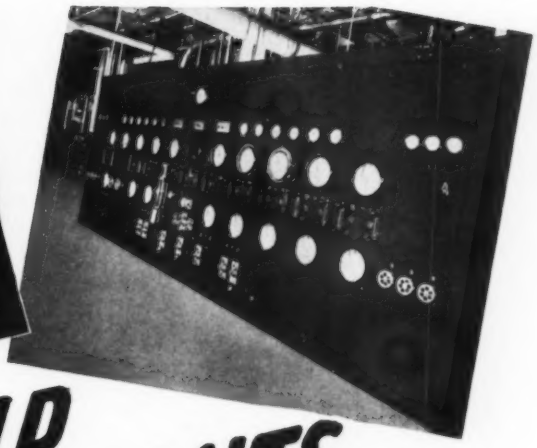
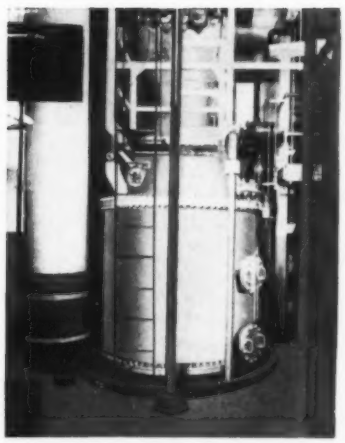




ACETIC ACID CONCENTRATION PLANTS



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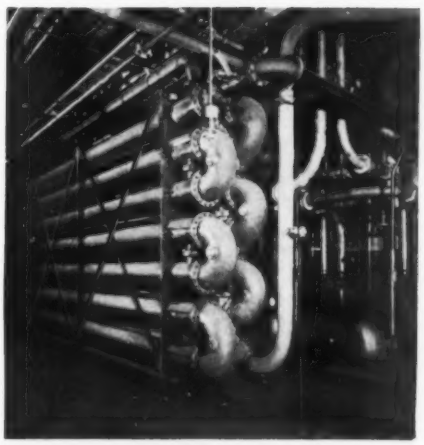

ACETIC ACID, the most important of the peace-time organic acids, now plays its vital part as an intermediate in the production of many essential war products. The economical recovery and concentration of this acid from aqueous solutions has long been one of the specialized endeavors of the Vulcan organization. Currently, an amount of glacial acetic acid in excess of 1,000,000 pounds per day is being recovered in plants utilizing Vulcan processes and equipment.

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CINDERELLA STARCH

(*Continued from page 376*)

The cyclo-hexa-amylose, and the Schardinger dextrins collectively, are obtained in such large yields from starch that many have wondered whether some predisposition toward formation of the cyclic dextrins were not expressed in the configuration of starch molecules. This thought naturally leads to the suggestion that perhaps the function of the enzyme is simply to break off loops of starch molecular springs and tie the broken ends together to form the ring-shaped dextrins (see Fig. 5). As a consequence, the short-branched amylopectin molecules should be less suitable for the action of the Schardinger enzyme than are the relatively long linear arrays of amylose, for branching may be expected to interfere with perfect coiling. Indeed the amylose fraction has recently been found particularly suitable for Schardinger dextrin formation.

The scientist seeking to confirm or investigate the details is handicapped now when he tries to see these extremely small, coiled molecules. He can only infer their presence, but the hypothesis of helical molecules offers considerable illumination to what have hitherto been puzzling starch phenomena. For example, within the amylose coils is room for iodine molecules. Placed in this position, the iodine is shielded from the water molecules of the starch solution. Normally, iodine in water solution is brown. The shielding results in the typical, starch-iodine blue color, more like that of iodine vapor, in which iodine molecules are essentially unaffected by their environment. Again, amylose shows blue iodine colors, whereas amylopectin iodine colors are reddish to red-brown, consequences of the relative perfection of coiling and shielding in the two starch fractions.

In the x-ray diffraction apparatus, the scientist does have a sort of eye with which to view the contortions of molecules. Unfortunately, the coils described above exist in water solutions or suspensions. When one attempts to look into them with the x-ray eye, one sees preponderantly the water molecules, which obscure the starch helices. Various alcohols and other organic substances, however, can precipitate the starch; if the task is done properly, it results in crystalline precipitates containing the starch and looking under the microscope like tiny dumbbells or six-petaled flowers. These precipitates give x-ray diffraction patterns of a distinctive type, which resemble patterns of precipitated starch iodide and probably also those of Schardinger dextrins. Thus, once again evidence points to a connection between starch in solution, the starch-iodine complex, and the configuration of the Schardinger dextrins.

The underlying basis of these relations would seem to be the coiled configuration, but the complexities of the interpretation of the diffraction patterns do not permit conclusive proof of this fact as yet. It can be said, however, that if we imagine that the alcohol molecules, like the iodine ones, are absorbed within starch helices, or that the helices are formed by the wrapping of starch chains about the alcohol molecules, some aspects of these patterns become understandable. The method for the fractionation of starch with butyl alcohol, mentioned earlier, probably owes its success to the fact that the coiled molecules of amylose can pack into a crystalline precipitate with more facility than can branched amylopectin ones.

The coiled molecular chains of freshly prepared solutions undergo changes on standing; these changes are usually described as "aging" or "retrogradation." In time, much of the starch precipitates out, and here too the x-ray diffraction method helps to identify the crystalline modification that is produced. It is the same as is in evidence in starch granules, and the interpretation would be that during retrogradation the coils re-extend to a more nearly straight configuration characteristic of their original condition in the granule. Once the high-temperature conditions originally causing gelatinization or coil formation are gone, as on cooling, the coiled form becomes unstable and slowly changes back to the extended shape. Again, straightened linear molecules of amylose find it easier to crystallize out in a regular manner than do branched amylopectin ones, so that retrogradation, as evidenced by actual precipitation, is a characteristic of amylose alone. Pure amylopectin solutions remain for long times without decrease in stability.

WHAT has been said is sufficient to indicate the contortions that starch molecules seem to undergo, and to make clear why a knowledge of these contortions for both starch fractions is necessary if one is to proceed intelligently to increase the industrial utilization of starch. Amylose and amylopectin both differ so markedly in configuration, in molecular size, and in such properties as solubility and iodine coloration that the uses to which they may be put will probably be quite different. Also, when working with either, one will want to realize that the chemical reactivity and physical properties may change with the coiling or uncoiling of the molecular chains.

From the purely scientific view, the recent developments in starch chemistry are likewise of considerable interest. Starch is not alone among natural polymers in its manifestation of both contracted and extended chain forms. Many proteins — for example, those of relatively inert animal tissues, such as the keratin of hair or the collagen of tendons — also show phenomena of contraction and extension. The ability of muscle protein (myosin) to contract and lengthen is one case where this property has been put to practical use by animals. Even reactions inside all individual living plant and animal cells — notably the changes in configuration undergone in cell division by the genetic determiners, which are known to be composed of a type of protein — may be a manifestation of extensible molecular characteristics. The extensibility of natural rubber has long suggested elastic molecules. Increase of knowledge regarding the coiling and uncoiling of starch chains will be of value in providing biochemists with a relatively simple example of this important phenomenon.

Starch occupies at least one unique spot among the natural long-chain molecules: It is the only one which to date has been synthesized in the test tube. To be sure, this synthesis is done with the help of biological aids, a class of enzymes called phosphorylases, but the unique position is not materially damaged thereby. Phosphoryl-

(*Concluded on page 384*)

THEM!

You are looking at the Board of Directors of one of the busiest companies in the world. It is the firm of Gremlin, Widget & Finella, Inc.,* specialists in the new light-metal headaches — magnesium migraines, aluminum ailments and general alloy trouble.

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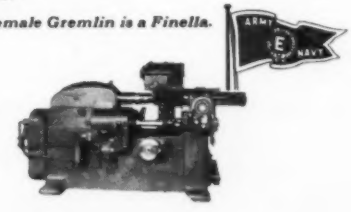

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CINDERELLA STARCH

(*Concluded from page 380*)

ases extracted from both animal and plant sources can, in a matter of minutes and in good yield, build large starch molecules from a simple phosphate of dextrose. Some of the enzymes form typical plant starches, or more strictly the amylose fraction, identical with natural amylose in respect to x-ray patterns, blue iodine color, and ready retrogradability. On the other hand, they may produce a glycogen ("animal" starch), which seems to be an exaggerated form of amylopectin, at least as regards extreme frequency of branching, short-chain length, red-brown iodine color, and stability of its water solutions. Thus we can look forward to the time when, for laboratory purposes at least, the scientist will be able to construct at will any type of starch molecule he may desire, without reliance on the products of nature.

All in all, the Cinderella starch twins seem not to have been strangers to the whirl of the scientific ball, and in time industrial princes may be expected to seek them out to try upon them the glass slippers of increased chemical application.

SHALL WE RATION CROWDING?

(*Continued from page 370*)

per cent for four-story buildings and 40 per cent for three-story buildings, our top limit of density would be 30 families, or approximately 100 persons, per gross acre (see Charts I and II). This figure compares with existing gross densities of 300 persons an acre for Parkchester and 600 persons an acre for Knickerbocker Village, two privately constructed, large-scale projects in New York City.

Similar standards could be computed for medium- and high-rent housing on the basis of predetermined coverage and height maxima. It should be understood that standards derived from the accompanying tables are based on an assumption of maximum efficiency in the design of the neighborhood plan and of the individual structures. Where the rehabilitation program for an existing residential area calls for substantial reclamation or repair of the buildings themselves and a retention of a major portion of the area at present devoted to streets, a lower figure for maximum gross density would have to be adopted.

What are the economic implications of the adoption of a density ceiling of 30 families per gross acre to be applied to all housing or redevelopment projects for urban areas regardless of land-acquisition costs? Such a gross density would permit an average net density of not over 65 families per acre, which means that at least approximately 670 square feet of net building land would have to be provided for each family accommodated in the project. In a privately built apartment project, in which the average rent was between $12.50 and $15.00 per room per month, it is unlikely that the developers could set aside more than $5,000 for the gross cost of each dwelling unit, assuming four-room apartments. Of

(*Concluded on page 386*)

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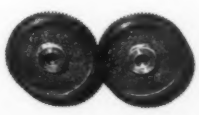

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SHALL WE RATION CROWDING?

(Concluded from page 384)

this amount, at least 80 per cent and possibly 90 would have to go for construction and development costs other than land, leaving only $500 to $1,000 for the latter item. In other words, the maximum price which the developers could pay for the land would be between 75¢ and $1.50 per square foot, depending on the unit cost of construction.

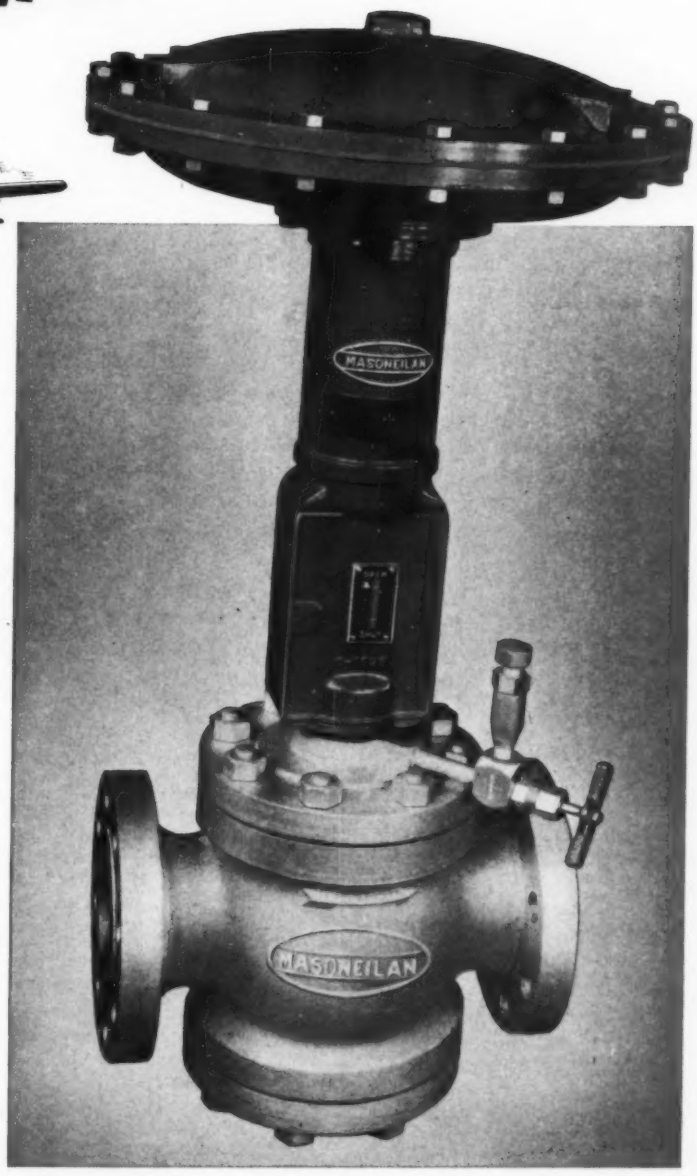
The example given above is intended only to be suggestive, but it has some interesting implications. It indicates that the values now placed on property in urban blighted areas are so high as to preclude private redevelopment without subsidy, whether such subsidy is in the form of capital grants or tax remission. Also it suggests that where prevailing land values do not exceed $1.50 a square foot, a density ceiling of 30 families per gross acre might be entirely practical under present conditions and that on 50¢ land the density could be restricted to one-third the above figure without hardship to property owners. It is not unreasonable to expect that some recognition of this point of view should find its way into zoning-law revisions which are now taking place or are under consideration.

If the approach suggested here has any validity, the same general procedure could be used in determining ceilings on the intensity of use for application to commercial and industrial areas. While adherence to carefully worked out quantitative standards will not itself insure the adoption by cities of desirable land-use patterns, at least such adherence would encourage sounder and more flexible programs of reconstruction and would help us to avoid in the future some of the worst evils to which we have been committed by unrestrained development.

This article, of course, is concerned only with the possibility of establishing over-all standards of *maximum* population density to meet the worst conditions of land crowding (e.g., where it is necessary or desirable to house in an existing residential area as many as possible of the present inhabitants). In general, the *optimum* density will probably be considerably less than the figure of 30 families per gross acre, and in the older cities the social implications may prove to be more important than the economic when the establishment of long-range development programs for these residential areas is undertaken.

The Boston *Globe*, in a recent editorial discussing post-war housing trends, put the matter mildly when it said that "it would seem that many people will desire to live where there is more land. Here is a problem that city management should consider. It will be awkward if there is much migration from the cities. Therefore it is indicated that living in a city should be made as attractive as possible." Not only are our living habits and the desires of our people clearly changing in favor of more spacious surroundings (if they were ever in favor of congestion!) but our technical improvements in transportation and housing construction increasingly tend to encourage the dispersion of population over larger areas. These factors should give our city fathers some pause for thought.

There Can't Be Any Guess in this Gas*



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SCIENCE AND SOCIETY IN THE POSTWAR WORLD

(*Continued from page 367*)

still. (And from this fact will flow many a headache for college presidents!) The exceptional men who lead the competing teams must have adequate resources.

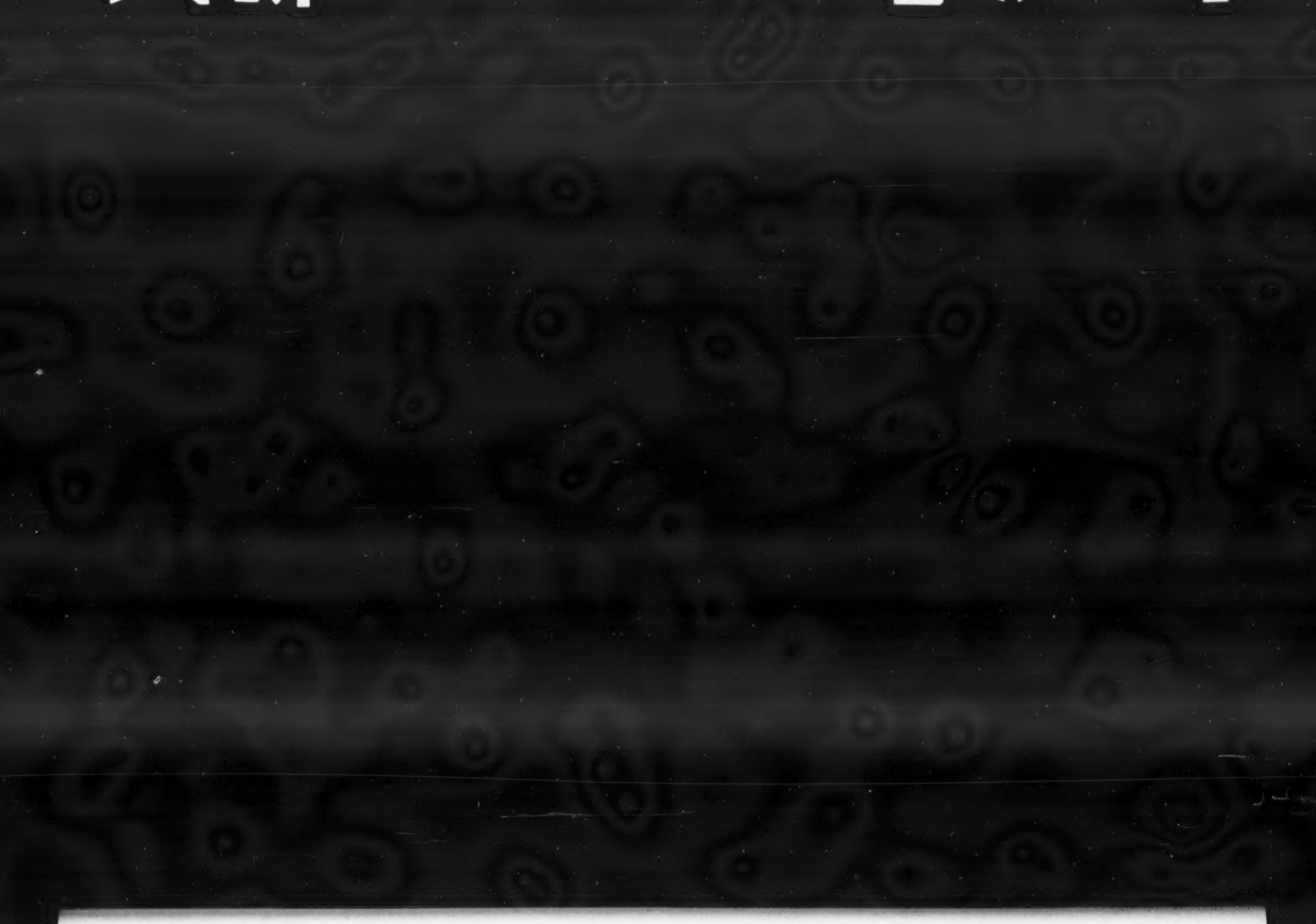
How is all this to be arranged? In part the answer turns on social, political, and economic factors which lie beyond the province of my remarks. It does seem clear, however, that certain prerequisites can be outlined — assuming, that is, that we desire a maximum development of the natural sciences and a maximum application of their results to the production of those things which civilization can employ.

At the base must be a truly universal system of education which enables the gifted boy or girl to complete the long process of scientific education without regard to the accidents of geography or birth. Then there must be in every field at least several equally strong and able groups of scientists or development engineers. For in no field should one organization be allowed to dominate the research or development activities, be that organization a government agency, a commercial company, or a research institute. The competing groups should be small enough to be flexible but large enough to be powerful. And their organization should be such that young men can operate effectively while they are still young. The dead hand of the past must not dominate the scene. Ideally, one would like to see each research group dissipated at least every 20 years, and a new one under a new frame of reference take its place. For one of the urgent problems is to keep a continuing flow of well-trained, talented youth going from our universities and technical schools into organizations where they can rapidly show their worth. Tradition and continuity are of the utmost importance in many affairs of man, but not in the field of research or the development of new industrial methods or machines. We all admire Russia today, not only for her incredible courage and fighting spirit but because of her success in applied science and technology. But I suggest we must remember that one of the key factors contributing to that success is that throughout Russia every part of her organization of science and technology is new and almost without exception manned by young men and women.

There is a great deal of talk about the proper organization of a research institute, or a research laboratory, or a development division of an industry. Undoubtedly there are types of organizations which are better than others. But give me the worst organization and let me build it afresh with young men, and I would guarantee that it will soon outstrip a better-organized group grown old in service and touched by the paralysis of age.

Competing groups of exceptional men, always flexible and mobile so that those outstanding in each generation can rise quickly to the top — that is the ideal arrangement for pure or applied science. One thing more is required. There must be an interchange of ideas and new discoveries. The interchange must be rapid enough to allow the work of one group to influence the other, but not under conditions which prevent the organizations

(*Continued on page 390*)



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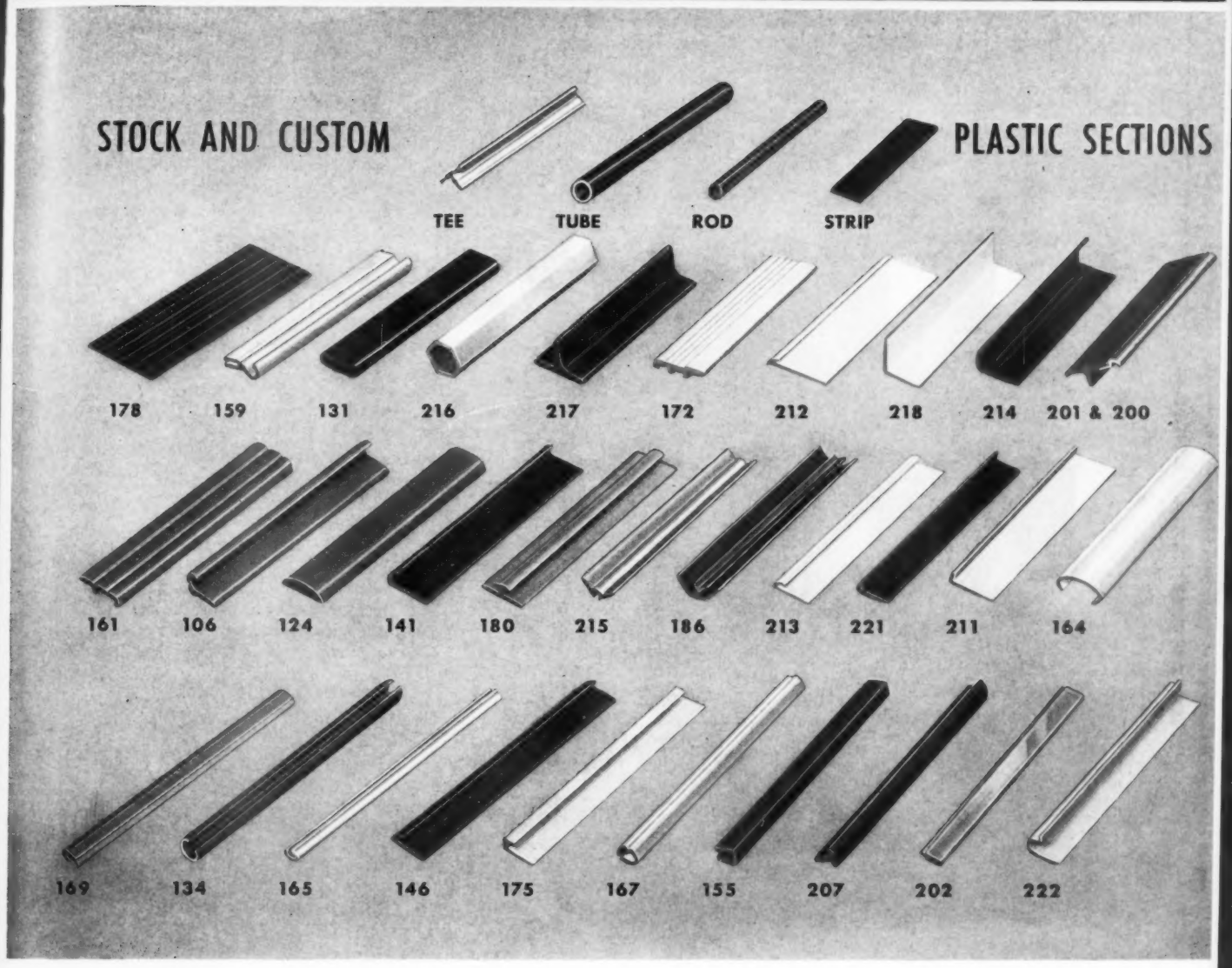

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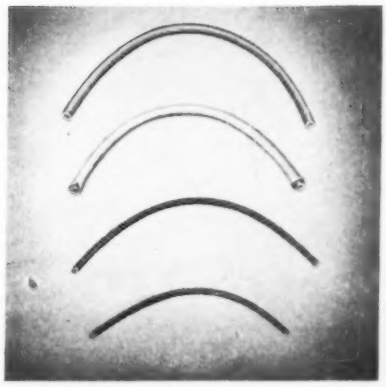

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SCIENCE AND SOCIETY IN THE POSTWAR WORLD

(*Continued from page 388*)

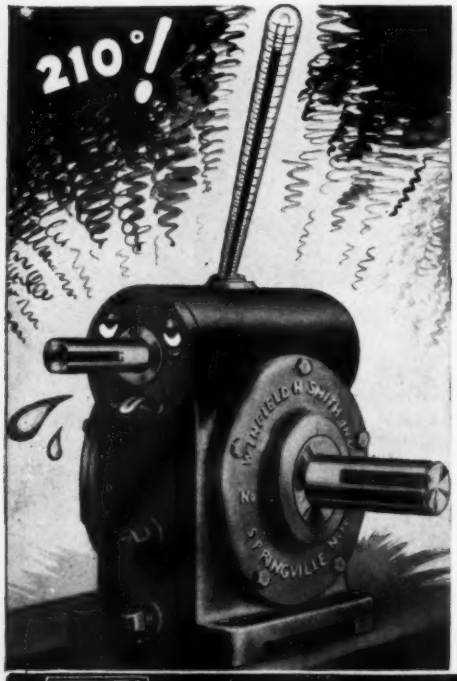
from having the satisfaction of seeing the fruits of their creative efforts. Here we come to one of the most difficult and complicated problems of modern science and industry. In pure science, publication in learned journals provides the medium of exchange. For industry, the patent system was established with the same end in view. The aim is to provide the inventor with a monopoly for a definite period of years in exchange for having "told the world" the facts about his invention. The pure scientist needs no such protection. There is little fear that his continued activities will be jeopardized if others rush into the field (though there is an unwritten code of ethics which frowns on exploiting another's scientific work).

With applied science, the case is otherwise. Large sums are required for the development of an idea or discovery. No one will risk the capital necessary for this development work (in the applied field, the equivalent of research) unless he is assured that a commercial rival will not enjoy the financial benefits which come from this investment. Either secrecy or patents protect those who put up money for applied research and the attendant developmental work. There is little doubt that, of the two, recourse to patents is far better, for then before long the information can be freely given to the scientific world by the publication of the patent.

If free private enterprise is to be abolished, then, of course, the whole situation changes and patents have no meaning. But I am assuming that our aim is to continue a system of free enterprise. For this purpose, undoubtedly certain changes in the patent laws may be desirable. It is not a simple matter to devise a system which will operate in a world bristling with new inventions and discoveries, and where interconnections between patents are of the utmost importance to the development of an art which may be in turn of great importance to the general welfare. Is not the whole problem to make the American system of free enterprise really free? But a discussion of this problem would take me too far from my subject. Let me repeat that if only one powerful group is operating in a field, whether this group be a government organization or a private laboratory, we do not have satisfactory conditions for the development of science or technology.

And now let me say just a word about scientific planning. In a recent Senate hearing, one witness stated: "The example that has been set by Russia and by our own industrial laboratories indicates plainly enough that technological progress can be made only by competent planning, direction, and organization. . . ." And another thoughtful observer of the current scene, deeply impressed by the mobilization of science for the war, has suggested that recognized leaders in the sciences must be willing to promote a research program for the national welfare, as determined by effective and realistic

(*Continued on page 392*)



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SCIENCE AND SOCIETY IN THE POSTWAR WORLD

(*Continued from page 390*)

national planning. I wonder. The vision of a scientific general staff floats before my eyes. For the specific end of war, such a scientific staff might try to function. Yet even in dealing with the comparatively simple technical objectives in time of war, few realize how great are the difficulties of planning. And the goal is never clear cut in times of peace. Let the advocates of scientific planning transplant themselves backward in history, decade by decade, in the last 100 years and see if they could have planned the future. It is the essence of research that one is dealing with an unknown world.

Of course, everyone recognizes that in certain types of scientific work — public health, for one example, and the development of improvements in agricultural techniques for another — a concerted attack on a problem by several agencies may be most fruitful. No one would want to discourage scientific co-operation in any field. Meetings, conferences, even committees, play a useful part in the progress of our knowledge.

My discussions here have been primarily related to research in physics and chemistry and its application through engineering to the industrial arts of peace. When we turn to applied biology, medicine, agriculture, forestry, the conditions are somewhat different. The relations to industry and to patents, for example, take on new forms. In these fields there may be more need both for governmental bureaus — as witness our agricultural experiment stations — and more opportunity for a co-operative mapping of programs by several groups. The basic conditions of healthy research are, however, to my mind constant. Obvious explorations can be carried out by a mass attack executed under orders from a co-ordinating committee, but the really new discoveries, the really epoch-making inventions, will rarely come that way.

To sum up: I recommend to all who look with favor on postwar planning, one master plan for research. This plan has five features: (1) Provide an educational system which offers real equality of opportunity; (2) find the exceptional men among those given this opportunity while they are still in training; (3) give these men every advantage and facility in the way of machines and helping hands; (4) be certain that there are many rival and independent groups competing for scientific and technical achievement, and that no group can long perpetuate itself; and, finally, (5) beware in times of peace of co-ordinating agencies with dictatorial powers — of a peacetime scientific general staff.

Nowhere in these recommendations have I suggested how research is to be financed or how the pecuniary rewards (profits, if you will) are to be distributed. But I hope I have made evident my convictions that underlying effective scientific progress are the ideals of a free society. I should like also to make it clear that I do not believe we can have a free society on this continent by trying to return to the past. Is not our hope, rather, to provide new adjustments in our social and economic framework to meet the conditions of a changed and

(*Concluded on page 394*)

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SCIENCE AND SOCIETY IN THE POSTWAR WORLD

(*Concluded from page 392*)

mechanized world to the end that we may continue free? Is it too much to expect that we can maintain at one and the same time free enterprise and mobility within our social structure — a condition under which no vested interest of governmental clique or private group will survive for long? To the extent that we approach these ideals, I believe the partnership of science and those who work for freedom will prosper and endure.

To forward such ideals is surely the duty and the privilege of our schools and colleges. For a moment, then, we may pause in the midst of war and look ahead — ahead to the time when our institutions may return to the unfettered teaching of the arts, the letters, and the sciences. When that happy day arrives, I hope that Sigma Xi and Phi Beta Kappa will do their part to foster a better understanding of the interrelation of the study of man and nature, believing with Thomas Jefferson that "a nation will be great . . . always in proportion as it is free."

RESEARCH AND PATENTS

(*Continued from page 372*)

desirable method of financing research work would also be lost if the value of patents were to be greatly reduced.

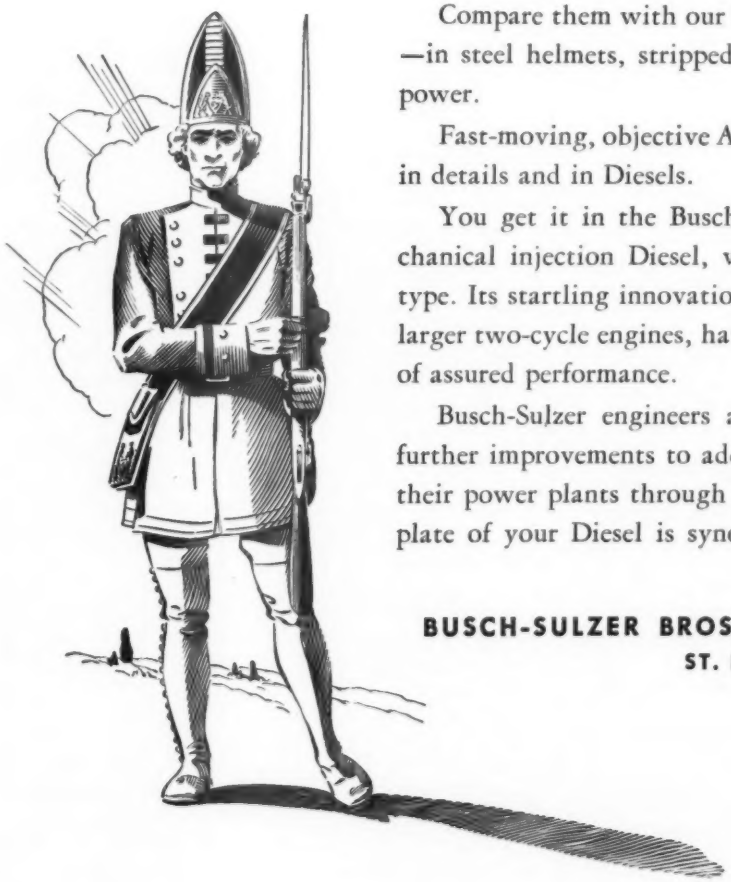
Probably the most serious effect that emasculation of our patent system would have on the future of research would be to encourage the use of secret processes. This would be highly unfortunate, since one of the principal factors in the rapid advance of science and technology in the past 30 years has been the practical elimination of the secret process in favor of full disclosure and patenting as the preferable method of protecting one's rights and interests in one's invention. If a large part of the reward for disclosure is taken away, the tendency to revert to the dark ages of secret processes will be inescapable. The loss to our country would not be merely that due to the absence of competitive use of new processes, but would be even more that due to the slowing down of the exchange of basic information and new ideas.

Intercompany research conferences and reports on new lines of development would practically cease, and early publication of industrial research work would seldom be permitted. Industrial espionage would rear its ugly head, and efforts to prevent it would force the elimination of the open-door policy of most of our industrial laboratories. As Charles F. Kettering has said, "When you lock the research laboratory door you always lock out a great deal more than you lock in." Serious weakening of our patent system would inevitably result in just such a situation. Modern industry based on applied science is a great co-operative affair which cannot thrive in a world ruled by secrecy.

Another unfortunate result of secret processes would be that a small company would no longer be able, as a prospective licensee, to get full information and detailed

(*Continued on page 396*)

Imagine a leatherneck in this uniform



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RESEARCH AND PATENTS

(*Continued from page 394*)

plans on competitive new processes. Though the owners of the secret processes might be willing to sell the know-how, they could not make prior disclosure of their processes for comparison with others, so that the small company would have either to buy a "pig in a poke" or do without.

Even workers in pure science who might discover a new principle would probably hesitate to publish it until they could work out some of the practical applications for sale on a secret-process basis, because once the new discovery was published it would largely lose its value. Although the attempt at secrecy might usually fail within a few years, the cumulative result of the loss of time between successive improvements would be a tremendous retardation of our progress. Under present conditions a new discovery is frequently published long before the patent is actually issued. The effect on the whole tempo of industrial progress is very favorable, because so little time elapses between the discovery and the general availability of the information to stimulate other researches in a variety of fields not even dreamed of by the original discoverer.

We must also not overlook the effect which a drastic weakening of our patent system would have on our future ability to get information from abroad. Foreign manufacturing conditions are usually better adapted to protecting the secrecy of processes than are conditions in this country; only the liberality of our patent system and the existence of a real market for worth-while patents have led most foreign inventors to make early application for a patent in this country. No country has, or can expect to have, a monopoly on brains. Anything, therefore, which will discourage our receiving prompt information regarding new foreign developments would be another serious bar to industrial and scientific progress.

Even although some foreign inventors might still apply for patents in their own countries, so that a certain amount of information would eventually become available to us, we could not secure the detailed plans, specifications, and know-how which can usually be obtained when it is possible to negotiate for a patent or a license. This know-how is particularly necessary on foreign patents, because their background of language and industrial technique is frequently not well understood in this country.

(*Concluded on page 398*)

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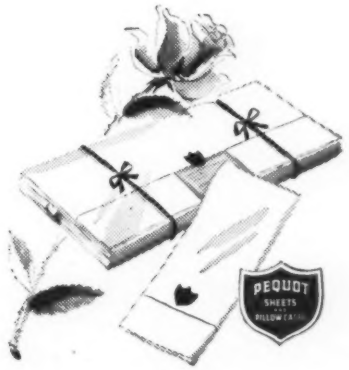

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RESEARCH AND PATENTS

(*Concluded from page 396*)

In conclusion, I hope that what I have said has convinced readers that our patent system is in real jeopardy and that this jeopardy is due to public misunderstanding which, in turn, is largely due to deliberate misrepresentations of the nature of the patent monopoly and the part which patents play in encouraging inventions and prompt public disclosure of them. The inevitable alternative, secrecy, would tremendously retard the progress of both science and industry in this country. In these circumstances, it is surely incumbent upon every scientist to take his share of the job of educating the public and our legislators as to the truth about our patent system.

In many ways the most encouraging aspect of the Washington outlook was the appointment by the President of a National Patents Planning Commission under the chairmanship of Charles F. Kettering. The committee has been expressly directed by the President to conduct a comprehensive survey and study of the American patent system and to make suggestions for its permanent improvement.

Rather than being stampeded into making drastic patchwork changes as we are urged to do by some of our theorists and nonresearch industrialists, we should certainly await with confidence the completion of the studies of the commission. I think we can reasonably anticipate a report as sound and important to our industrial picture as the recent Baruch report on the rubber problem. If such a report is given the weight it deserves, I believe we can look forward with confidence to the future of research and invention in this country, which is our greatest hope for prompt postwar readjustment of our economy.

Were it my job as supersaboteur to destroy America's future greatness, I can think of no more effective way than to destroy our patent system. The tragedy is that if we permit impractical theorists and faddists to distort the facts and hypnotize our nation into this act of hara-kiri, all of us will suffer and yet no adequate punishment can be meted out to those who are really responsible.

Let us not by our inaction have any share in such a terrible responsibility.

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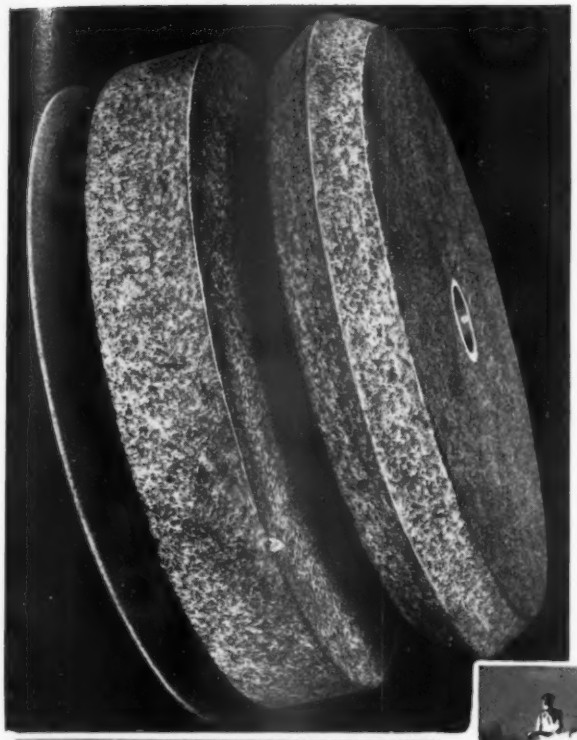

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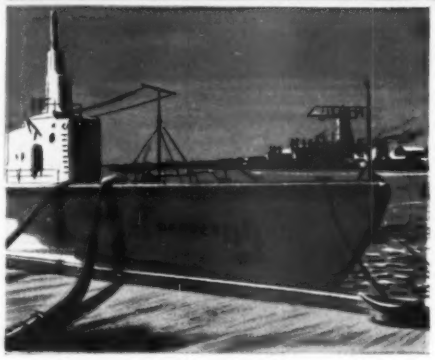

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